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A Waterworks Number

THE annual convention of the American Waterworks Association at Cincinnati next week will focus the attention of engineers throughout the country on problems relating to one of the most important branches of civil engineering. It is for this reason that the Engineering Record has made this issue a waterworks number. But in planning the contents the aim was not merely to present data on each of the principal sub-divisions of the general subject—such as filtration, chemical treatment, pumping, meters, pipe, and waterworks construction—but to select as subjects for articles those works which would best illustrate the latest progress in the art. For example, the alum manufacturing plant at the Columbus waterworks, described by Charles P. Hoover, is the first of its kind which has been placed in service, and has been responsible for a marked reduction in the cost of chemicals. The centrifugal pumps at Akron, dealt with in F. A. Barbour's article, claim interest because of the unusually varied operating conditions with which they have been designed to cope. The elimination of brass screens in the Cincinnati filters, as discussed by J. W. Ellms, marks an important change in the construction of rapid filter beds and is based upon actual operating experiences at a large plant. Many useful hints on the details of filter construction and design will be found in James W. Armstrong's description of the work at Baltimore, now nearing completion. A decided improvement in the operation of the Torresdale slow-sand filters at Philadelphia will be effected by the new sedimentation basin, the subject of Francis D. West's article. The direct-explosion pumping plant in Texas is a pioneer of this type in the United States, and several new questions of administrative policy have been introduced in connection with the work of constructing the new Winnipeg aqueduct. The contents of this issue indicates forcibly that during the past year waterworks engineers have not been marking time, but have been pressing onward in the march of progress.

Sedimentation at Torresdale Filters

EXCESSIVE turbidity and slow-sand filters have always been arch-enemies in the water purification field. Before the design of rapid filters employing coagulation as a preliminary treatment reached its present state of development the slow-sand filter was called upon to bear the brunt of purifying waters of all types, irrespective of the difficulties attending high turbidities. It is interesting, therefore, to read on page 591 the latest chapter in the history of the country's largest slow-sand plant—the Torresdale filters at Philadelphia. In spite of the fact that preliminary filters, operating at high rates, were introduced to relieve the turbidity load on the final or slow-sand units, thereby increasing their output and reducing the costs of cleaning, the city, at times, has barely had a sufficient supply of filtered water for its needs. The opposition to meters in Philadelphia, in the face of repeated appeals for their installation by the city's technical advisers, has, thus far at least, militated against any effective campaign of water conservation. The alternative was to increase the plant output and this will be accomplished by the coagulation and sedimentation basin described elsewhere by Francis D. West. This addition to the works will remove from the raw water about 60 per cent of the suspended solids which formerly reached the pre-filters and clogged the slow-sand beds. Not only will the new basin make possible a yield of 220,000,000 gal. daily, but it will halve the costs of sand-cleaning, remove color from the water, prevent growths of algae on the final beds, and produce a clear, safe water continuously, without resort to sterilization. As an economic factor in the operation of the filter plant the sedimentation basin will assume a good deal of importance.

New Policies in Aqueduct Construction

SO unusual are the conditions under which the 100-mile Winnipeg aqueduct will be built that the work occupies a unique place in waterworks construction. The several municipalities combining to form the Greater Winnipeg Water District have assumed direct responsibility for the selection and transportation to the work of the principal materials of construction. The district has built and will operate its own construction railroad, will purchase all cement directly instead of delegating this duty to the contractor, and will not only supply to the contractors sand and gravel but will also grade this material in the proper proportion for use as concrete aggregate. These three innovations in administrative policy are discussed in the article on page 594. Local conditions, of course, had much to do with the approval of this plan for the conduct of the work. The aqueduct line extends through almost impassable swampy country where no transportation facilities were available. Without the railroad it is probable that reasonable bids for construction could not have been secured. The direct purchase of the cement was decided upon to insure sound, waterproof construction. The decision to deliver graded sand and gravel to the contractors was influenced by the difficulty of securing, even in a single pit, material which did not show such wide variations in quality that its direct use by contractors would have entailed an amount and quality of inspection almost impossible of attainment and exceedingly costly. The purchase of cement by a municipality or State is not new and has its counterpart in the buying of bituminous materials for road construction by such State highway departments as those of Massachusetts and California. The large-scale delivery to contractors of graded sand and gravel for concrete, however, is believed to be decidedly novel. It is clear that under the Winnipeg plan disputes between engineers and contractors regarding the quality of materials will be reduced to a minimum, if not entirely eliminated.

New Theory of Water-Main Breaks

DESIGNERS of large cast-iron pipe lines, specification writers and contractors should take particular note of the analysis, on page 588, of the breaking of water mains in Cincinnati over a year ago. Longitudinal stresses of large amount are believed to have resulted from end contact of a number of adjoining pipes. In large size pipe where the individual sections are, in comparison with the diameter, short, stubby cylinders, it is easy to conceive of the enormous strains set up in a small area when the spigot end is in contact with the bell at one point only, and the pressures are applied on the convex side of a slight curve. The tendency is to straighten out a flat arch ring in which the faces of the voussoirs touch at points only, resulting in enormous localized unit pressures. Clearly one remedy for this difficulty is to allow a definite clearance and to insist on its being attained. For certain large mains laid around the Philadelphia pumping stations such a clearance was called for, and after studying the Cincinnati break at least one consulting engineer has concluded that in the future he will specify clearances on lines in which the pipes are as small as 16 in. The question deserves careful consideration. Waterworks superintendents should observe the condition of joints for a number of lengths of pipe on each side of breaks. There is need for discussion of points such as the following: How much clearance shall be allowed for different sizes of pipe? How much variation from a true plane may be allowed at the ends? Shall wood spacers be used and may they be left in place? The Engineering Record will be glad to open its columns for a discussion of these points.

Steel Column Tests

IN last week's issue, page 549, there was presented and discussed briefly the available results of the two extensive series of column tests now in progress at the Bureau of Standards under the co-operative auspices of committees of the American Society of Civil Engineers and the American Railway Engineering Association. Since the results thus far reported embrace only 20 of the 288 or more tests contemplated in the program, any attempt at drawing definite conclusions would be obviously premature and unwarranted. Nevertheless, attention may profitably be directed to certain general considerations and tendencies suggested by these and earlier tests, as well as to certain features of the present schedule.

The basic question governing the selection of suitable working stresses for columns, to which the answer must be sought in tests is: What unit stress marks the life limit of a column under permanent or oft-repeated loading, provided premature local failure through faulty design is precluded? In the abstract this question may be reasonably answered by saying that it is that maximum unit stress within which permanent deformations, in the form of minute axial sets or even lateral deflections, experience no increase under long-continued or repeated loading; and that this should be recognized as the critical unit stress on which working stresses should be predicated. To determine its value experimentally is, however, a very different matter. To do so under oft-repeated loading with appreciable intervening time intervals, analogous to the service conditions of a bridge member, would be obviously impracticable. Moreover, it may be doubted whether attempts in that direction would serve any useful purpose. Within true elastic-limit loading the time element is clearly not a factor, and for higher loading intervening periods of rest between successive loads would affect the results favorably rather than otherwise.

It seems highly desirable, however, that in the continuation of these tests the committee should adhere to its understood purpose to apply and release each load repetitively, without increase, and as often as there are resultant increments of permanent set. By analogy with Bauschinger's classic tests in tension, the minute permanent sets, observed even under relatively low initial stresses, may be expected to show no sensible increase under repetition until a limit similar to his "stretch-limit" in tension is reached, beyond which they may be expected to increase progressively without increased and eventually under decreased loading. It may also reasonably be anticipated that this limiting unit stress will be appreciably lower than the ultimate strength under loading continued progressively up to failure, and that it will probably stand in close relation to the limiting static load that can be maintained indefinitely. The influence of the time element, in this sense, on the strength of steel columns has, within our knowledge, never been determined. Observations on a series of small steel struts permanently loaded for the study of the phenomena of gradually progressive yielding should present no very great difficulty or expense, and would seem to hold out promise of valuable collateral information.

The manifest purpose of conducting the current tests with extreme care and accuracy is in principle highly commendable. Nevertheless, it may well be asked whether the program of observations under which progress is made at an average rate of only two tests per week is not unduly elaborate and time-consuming. If an exhaustive study of the mass of data already obtained, of which relatively little has been published, should make it apparent that certain features are either perfectly typical or hopelessly erratic, an abridgement of observations in these directions would be clearly in order. It is no reflection on the committees to point out that it is a human tendency to defer such preliminary analyses too long, and perhaps with a subconscious feeling that the possible accumulation of excess data is on the safe side. In relation to tests which promise to cover a period of three years, as now prosecuted, it is of vital importance that there should be no waste of time and energy through the continuation of unnecessary observations, and at the possible expense of data in many other much-needed directions.

While the plan of the committee by which the material and manufacture of these test columns are governed by avowedly "gilt-edged" specifications, with a view of minimizing the effect of all variables save the particular one under investigation, has much in its favor, the question as to the extent to which the results are noticeably influenced by requirements which are clearly impracticable in a commercial sense is sure to present itself insistently. It is to be hoped, therefore, that some of the columns tested will soon be duplicated under the A. R. E. A. specifications, and that the manufacture of the remaining columns will be held in abeyance pending a comparative study of the results. The factors involved are so numerous and complex that despite extreme efforts at control it may well be that the anticipated gain will prove illusory, or so slight and uncertain as not to warrant adherence to requirements so radically at variance with commercially practicable conditions. The burden of proof in this matter rests clearly upon the committee.

To mention only a single item, the yield point under the present specifications is confined to the narrow limits of 37,000 to 39,000 lb. per square inch, whereas in connection with Howard's recent tests, for example, of columns for the Pennsylvania Lines West of Pittsburgh the yield point was found to vary as much as 25 per cent in steel from the same melt, and similar variations were observed in different parts of the metal in the same column. Moreover, it is to be remembered that such variations are liable to occur in metal from the flange, root and web of the same section and that the elastic limit, which may deservedly be regarded as a more rational criterion than the yield point, may exhibit equally great or greater variations which may bear no particular relation to those in the yield point. The effects of these irregularities are further aggravated by unavoidable initial stresses in rolling and cooling, and those induced by cold-straightening, punching and other shop manipulations.

In the light of present evidence it is hardly to be doubted that the average maximum oft-repeated or permanent load is substantially lower for short columns than for tension members of the same sectional areas, and that it is also subject to greater variations. How its value is influenced by the form, size and thickness of cross-section; at what limits length becomes a factor—to what degree and in what relation, if any, to the radius of gyration—are among the many questions which the present investigation will be looked to for at least a partial answer, not to mention the many important, though in a sense subsidiary, questions relating to details of design.

It is to be regretted that the effective length of the testing machine between compression heads is restricted to about 33 ft. This limits the radius of gyration to about 4 in. for a slenderness ratio of 100 and to only 3.3 in. for the maximum ratio, 120, in the present program. These limits are much below the averages for important members in current engineering practice. It is to be hoped that the 10,000,000-lb. vertical testing machine of the Bureau of Standards in Pittsburgh will have its present effective length of 25 ft. increased at no distant date to the 65-ft. length originally in view.

American Society of Civil Engineers on Eve of Important Action

IT is difficult to appraise the influence of the action, reported in this journal last week, page 570, of local associations of members of the American Society of Civil Engineers endorsing the recommendations of the conference of association presidents that there be formed in each district a district organization. If this plan be made effective by the board of direction of the society, as in all likelihood it will be, for it evidently has the support of a majority of the members of the society, it will be one of the most important steps in the society's history.

This journal has long had the conviction that the society held too impersonal a relation to its members, being a thing apart, in which they might participate only at long reach, as it were, through contributions to the proceedings and a visit at very long intervals to an annual meeting or a convention. The remedy, it believes, was in a system of district organizations binding into groups members resident in States likely to have the same local interests. For that reason, just preceding the last annual meeting and the conference of local association presidents, the Engineering Record strongly advocated a "Federal" form of organization. That is exactly what the associations have now recommended to the board of direction.

Undoubtedly the consummation of this plan will result in stirring up greater interest among the members of the society. To them the society will no longer be a distant entity, but a living body in which their influence can be made felt through contact with those of similar interests, both local and professional. Undoubtedly there will come district conventions, and, inevitably, greater activity in those public affairs in which the influence of members of the society would be beneficial.

Aside from the local society, however, the fact that the district alone will nominate and elect its representatives on the board of direction will be a powerful magnet to attract the deep interest of those within the district.

All in all, the society is to be congratulated on being on the threshold of so great a development in its affairs. It presages a future greater even than the past—one in which strength will come not alone as in the past, from a farsighted and able body of officers, but from the activity and vigor of an interested membership.

The society will not rest with this accomplishment. This journal has argued for greater publicity for committee work. That has been in part accomplished and even more is to be expected in the near future. If now the spirit of the meetings throughout the country will take on the animated, human character of those of the most successful of the local associations the society will have removed the ground for the three chief criticisms which have recently been leveled at it.

The Award in the Western Railway Arbitration Case

RAILROAD men who are asked to elucidate the award in the arbitration of the demands of western railway employees reply that it will take weeks to figure out just what it will mean to the roads and to the men. It is only clear that increases of wages or rates of pay have been given to 64,000 enginemen, firemen and hostlers employed by 98 roads. Neither the roads nor the men are satisfied or even reconciled to the award, and the Newlands act, under which the arbitration was conducted, is condemned as an "inadequate device for the settlement of industrial disputes." It is not necessary to take these protests too seriously. One union leader who publicly condemned as an outrage upon labor the terms of the award in the eastern railroad wage arbitration, said privately that he was surprised that they "got away with so much."

At all events the western railroad men have received substantial advances, amounting to as much as 15 per cent in some cases, and many adjustments of working conditions have been made in accordance with their demands. Among the demands that the arbitrators refused was the abolition of surprise tests. This is something in which the public has a direct interest as a measure of safety, and it is cause for satisfaction that surprise tests have been upheld in spite of the bitter attack made upon the practice by the men.

While it would be presumptious to criticise the award in detail without more definite information than the reports of the arbitration have given, it is probable that it comes as near essential justice as any compromise can come. The naïve contention of the men that the roads could afford to pay the extreme of their demands evidently was dismissed if it was ever seriously considered. The proof that the men were earning the wages asked for was inadequate. It is not unjust to say that this side of the case was slighted, apparently on the theory that the men were sure to get some part of their demands whatever the evidence might be.

So far as the standing of the Newlands act is concerned, it is hardly affected one way or the other by the western award. The law is one for compromising disputes between employers and employees and by this means avoiding strikes. It will never accomplish exact justice to either side of a labor dispute, but it does reach tolerable adjustments. If labor has any complaint against arbitrations under the federal law, railway employers have the much more serious complaint that whatever the merits of their case against labor's demands some part of them are sure to be conceded. In other words, the awards do not represent the precise convictions of any arbitrator or exact deductions from evidence; they are adjustments of extreme demands.

Another Milestone in Filtration

FROM alum boiler to water basin has been the dream of many a chemist in charge of a filtration plant, and now there is an installation at Columbus, Ohio, which is practicable and economical. The expenditure for aluminum sulphate years ago made the financial factor a determining one in the decision between slow-sand and mechanical filters. Later, when it was conclusively proved that various Middle-West waters would not submit to slow-sand treatment under any circumstances, a more scientific basis—relative turbidity content—was, and still is, the greatest factor in determining the type of plant to install. Reams of calculation paper have been covered with comparative estimates of the two types of filters for supplies in which the turbidity was, say, below 75 parts per million. The coagulant bill per million gallons for rapid filters could always be counted on to counterbalance the high interest charge of the more expensive slow-sand bed, but a reduction in the coagulant bill to $10 per ton practically eliminates this item as a factor in determining the type of plant to install.

At Columbus another feature, the coagulating matrix, as described on page 576, is of very vital interest, particularly for low-turbidity supplies when the slow-sand method is feasible, and Mr. Hoover could well have dilated on that point. Waters like that of Lake Michigan at the Evanston plant carry so little turbidity at times that floculation is obtained with difficulty. Unfiltered syrup of alum contains a siliceous residue that furnishes the necessary crystallization points to make good coagulation practicable. Ordinarily an impure chemical is not desirable, but in this case the residue is of direct value. Because of this fact halloysite, a less expensive mineral carrying a smaller percentage of alumina than bauxite, is quite likely to supplant bauxite.

Syrup of alum plants probably will not spring up all over the country until a much larger proportion of our plants are operated by technical men. Ability to carry a ward in an election does not necessarily qualify one to operate an acid cauldron. Adequate operation of most small plants cannot be obtained, even as it is, let alone adding a chemical manufacturing establishment. Cleveland, Cincinnati and St. Louis are large enough to balance the new method against the lime and iron treatment. Seven years ago the plan of making alum on the spot was worked out on the Pacific Coast in connection with the proposed rapid filters at Oakland. Alumina-bearing deposits exist on the west side of the Rockies of which Mr. Hoover does not speak. The New Mexico deposits should be available to Denver.

Possibly it will be economical to ship syrup of alum in tank cars to smaller cities in the vicinity of larger plants. Mr. Hoover does not take up the point. Evidently it is susceptible of comparison with present methods as soon as manufacturers are prepared to furnish the syrup. The value of the coagulating matrix should be given due weight in any such comparison.

Lest anyone get the idea that Columbus has arrived at its result over night it may be said that the idea was conceived two years ago and since then has been made the subject of constant experiment. At the time of the floods in Ohio a representative of this journal was shown the miniature equipment with which 10,000 gal. of alum syrup had been made, a little at a time. The syrup was stored until the river was in flood, the idea being to try it out on a muddy water. When the river turbidity reached 2000 parts per million a day's run was made with such satisfactory results that further experiments were carried out only to get designing data for a full-size unit. As in all experimental work some first thoughts did not work out successfully, and anyone seriously considering the process can profitably pay a visit to Columbus.

At the Columbus plant, Mr. Hoover points out, it is hardly fair to make any charge for labor, because no additional labor is required to operate the new alum plant. When lump alum was being used it was necessary to unload it from the cars, sack and weigh it, store it, elevate it to the third floor of the head house, stack it up there and finally dissolve it in solution tanks as needed. In addition to all this handling there was three times as much material to move and three times as much storage space required, because 1 ton of bauxite will make 3 tons of alum.

The Columbus workers have rendered a great service to the profession and to the public at large dependent on rapid-sand plants.

Columbus Waterworks Makes Its Own Alum—A Revolutionary Step in Water Purification Practice

Aluminum Sulphate Syrup, Manufactured for the First Time at the Filter Plant, Successfully Replaces Commercial Crystallized Product at Estimated Yearly Saving of $6000

By CHARLES P. HOOVER
Chemist in Charge, Columbus Water Softening and Purification Works

THE first syrup-of-alum plant ever built at a water purification works has recently been installed to furnish coagulant for the waterworks at Columbus, Ohio. Although it has been in operation only since January, it has been a success both technically and financially. An investment of $12,000 was required for the construction, and it has been conservatively estimated that $6000 per year will be saved the city in the cost of alum. Between 800 to 1000 tons of alum will be manufactured during the coming year at a cost of about $10.50 per ton.

The process generally employed today for coagulating water consists of an application of a solution of aluminum sulphate prepared by dissolving in water the previously crystallized chemical. By the new process the syrup of alum is fed direct from the boiling tanks, via the dilution tanks, to the water.

In order to show the advantage of the new process as used in Columbus, and to point out the advantage of making alum at the point where it is to be used, a brief explanation of the old process of making alum for water purification purposes will be necessary.

NEW AND OLD PROCESSES COMPARED

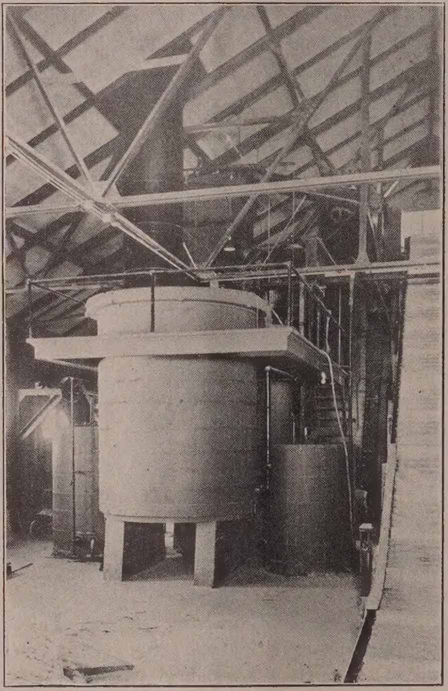
Lump alum is a combination of bauxite (a Southern clay containing from 58 to 60 per cent alumina, the aluminum being present as $Al_2O_5H_4$) with sulphuric acid. By mixing the two in lead-lined tanks and boiling for a period of from six to eight hours, the first step in making the alum is taken. The following reaction takes place:

$$Al_2O_5H_4 + 3\,H_2SO_4 = Al_2(SO_4)_3 + 5\,H_2O.$$

The resultant solution is a mixture of aluminum sulphate and silica, and must be filtered to obtain the clear aluminum solution. The filtering process is perhaps the most costly, tedious, and annoying step in the whole procedure of alum making, because the finely divided particles of silica present in crude sulphate solution quickly clog the pores of the filtering medium to such an extent that it is often necessary to force the material through the presses under considerable pressure. After being filtered the alum solution is boiled to expel the excess water. The expense of concentrating the syrup must be taken into consideration, because the density is increased from between 25 and 30 deg. Be. to a density of between 58 deg. and 60 deg. Be. The solution is then discharged into trays, and on cooling crystallizes to the alum cake. Then crushed or pulverized cake is shipped either in bulk, in barrels or in sacks.

FIVE STEPS IN ALUM-MAKING SAVED

In the Hoover process bauxite and sulphuric acid are boiled in lead-lined tanks until a basic solution of aluminum sulphate is obtained. The solution is then diluted with water (usually enough water is added to make 500 gal. of the solution, equivalent to 1 ton of 17 per cent Al_2O_3 alum), and measured as needed into alum solution tanks, where it is diluted with sufficient water to make a standard solution, which is then applied to the water under treatment. By this process five distinct steps in alum making are eliminated—filtering, concentrating, crystallizing, grinding, and redissolving. The plant comprises two lead-lined boiling tanks, two alum-measuring tanks, one acid-measuring tank, one sludge tank, one storage tank for sulphuric acid, one crusher and one pulverizer for the bauxite, conveying, elevating, and transmission machinery, bauxite storage bins and weighing device, piping, valves and fittings. This plant, some features of which have been made the basis of patent application, has been in continuous operation since the middle of January. The plant was finished and the first alum made Dec. 25, 1914, but experiments had been carried on for two years.



COLUMBUS ALUM PLANT, SHOWING BOILING, SLUDGE, AND MEASURING TANKS

COAGULATING MATRIX

The crude alum solution containing silica or other inert material from the bauxite, probably better defined as chemical mud, is applied to the water under treatment, the chemical mud mixes with the suspended particles present in the water and finally becomes entrained or coagulated by the precipitated aluminum hydrate and settles out in the settling basins. The crude solution, containing the chemical mud in suspension until the metallic sulphate has been converted into hydroxide, has a function not possessed by alum solution prepared by the old process, namely, forming a matrix or nucleus for starting the coagulation. This feature produces not only more efficient results with less coagulant, but also affords the process universal applicability irrespective of any lack of natural turbidity.

SOURCES OF BAUXITE

Bulletin 2 of the Geological Survey of Georgia states that the first discovery of bauxite in America was in 1887 at a point a few miles southeast of Rome, Ga. At present the known workable deposits of bauxite are limited to a few localities in Europe and the United States. Its occurrence in Europe is in France, Germany, Austria and Ireland, and in the United States, in Georgia, Alabama, Arkansas and New Mexico. The mining of bauxite in the southern States has shown a great growth during the last few years, the annual production passing the 150,000 long ton mark in 1911.

As a rule bauxite is easily mined because of its comparative softness beneath the surface. In most cases it may be dug up with a pick, although black powder is sometimes used to loosen it from its position. The bauxite is usually removed in steps or benches, and loaded into small mine cars. The ore contains a large percentage of uncombined water, which, unless expelled or driven off before shipment, makes it an important factor in the freight cost. After being crushed the ore is passed through long rotary kiln dryers, similar to rotary cement kilns. Three grades of ore are mined, first, that used in the manufacture of metallic aluminum; second, that used in the manufacture of alundum, and third, that used in the manufacture of aluminum salts.

On account of the strict specifications drawn for sulphate of alumina by those in charge of water purification plants and paper mills, only the ore containing less than 2 per cent of ferric oxide (Fe_2O_3) is used in making aluminum sulphate. The more ferruginous ore is used in the manufacture of metallic aluminum, and the very purest grade of ore is used for the manufacture of alundum.

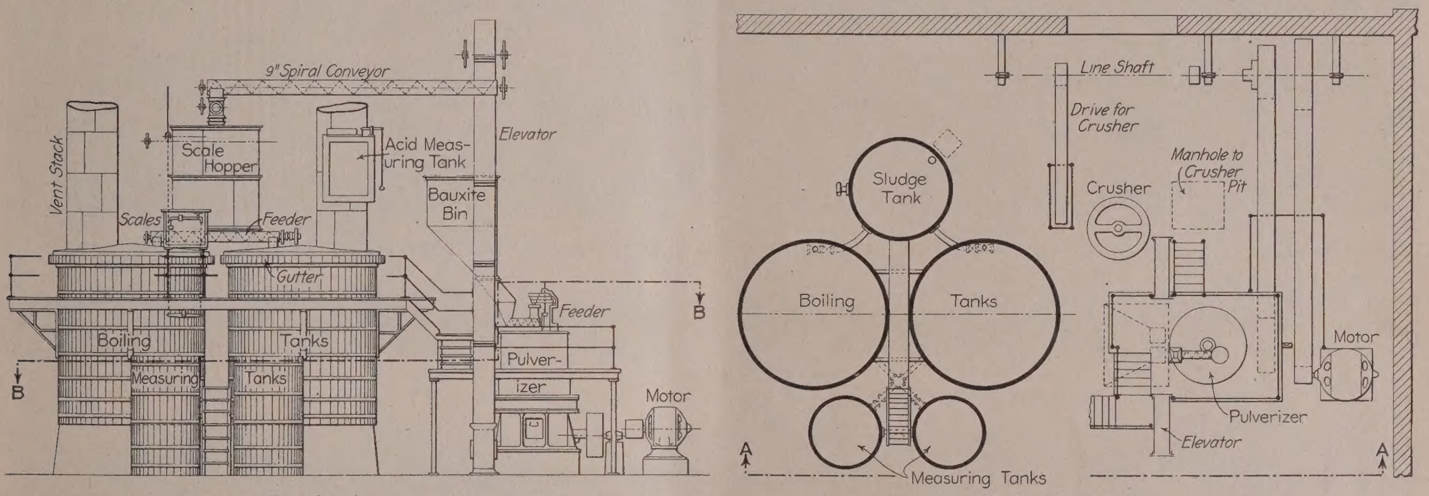
The possible yield of bauxite, according to the above-mentioned Bulletin, is greatly limited by the fact that nearly all but the first grade material is discarded, thereby necessitating the exclusion of a vast quantity of ore, which should, by proper skill and manipulation, find ready utilization at good prices. This condition was, perhaps, made necessary in the beginning, when markets had to be established, in order that home material might compete with the cheap and less pure foreign bauxites of long standing and reputation. The principle has been so rigidly adhered to by both operator and consumer, during the period of working in the American fields, that it has resulted in creating a demand for the first grade ore only, with practically no sales for the lower grade bauxite.

The writer believes that it is not necessary to demand bauxite of highest purity for making aluminum sulphate to be used for water purification purposes. It seems entirely possible that much of the cheaper grade bauxite could be used to advantage in making alum for water purification purposes.

BAUXITE SPECIFICATION

The specifications for bauxite now used at the Columbus plant are as follows: The bauxite is to be crushed and dried so as to contain not over 3 per cent moisture. By analysis there shall be not less than 52 per cent of Al_2O_3 and not more than 3 per cent of Fe_2O_3.

The contract for furnishing the supply needed for the period ending July 1, 1915, was awarded to the Aluminum Company of America, Pittsburgh, at $5.50 per long ton, f.o.b. Bauxite, Ark. The freight rate to Columbus is $4.40 per long ton, therefore a ton of 2000 lb. delivered at Columbus costs $8.84.



Elevation A-A

Sectional Plan B-B

BY INSTALLING AN ALUM MANUFACTURING PLANT AT THE FILTERS COLUMBUS TAKES REVOLUTIONARY STEPS IN WATERWORKS PRACTICE

Bauxite contains from 58 to 60 per cent Al_2O_3, whereas ordinarily filter alum usually contains 17 per cent Al_2O_3; therefore 1 ton of bauxite will make a little more than 3 tons of alum ($Al_2(SO_4)_3 14 H_2O$).

The Georgia Bulletin published in 1904 lists the following companies as either owning or working bauxite deposits in Georgia: The Republic Mining & Manufacturing Company, the Georgia Bauxite & Mining Company, the Dixie Bauxite Company, and the Southern Bauxite Mining & Manufacturing Company. Dealers known to the writer who are in position to quote prices on bauxite are: Aluminum Company of America, Pittsburgh, Pa.; Winthrop C. Neilson, Harrison Building, Philadelphia; National Bauxite Company, Philadelphia, and Globe Bauxite Company, Joliet, Ill.

HALLOYSITE, A SUBSTITUTE FOR BAUXITE

Good filter alum may also be made from halloysite, the approximate chemical analysis of which is as follows: Soluble alumina, 38 per cent; insoluble material (silica, etc.), 40 per cent, and water, 22 per cent. Attempts to make crystallized alum from halloysite have failed because it has been found almost impossible to filter or separate the insoluble portions of the halloysite from the aluminum sulphate syrup. At the Columbus water purification plant, one tank, equivalent to about 6 tons of alum, has been made successfully and used. Several carloads of this material have been purchased, and further experiments with the use of halloysite as a base for making alum solution will be made.

The North American Chemical Company, Urbana, Ohio, has a very large deposit of this ore (estimated to be 15,000,000 tons) located near Rome, Ga. The writer has been assured a number of times that if a market can be created for halloysite, the material can be furnished f.o.b. cars Rome, at approximately $2 a ton.

Sulphuric acid used for making alum is contracted for at the Columbus water purification works under the following specifications: The sulphuric acid shall be that known as 66 deg. Be. contact process acid, and shall contain not less than 92 per cent H_2SO_4. The material shall be delivered at a uniform rate of not less than 30 tons per month, or at such increased rate as shall be directed.

The sulphuric acid shall be shipped in acid tank cars, provided with all necessary connections for removing the acid from the car by air pressure.

COST OF OPERATION

The following is an estimate of the cost of producing 100 tons of 17 per cent Al_2O_3 alum solution:

ESTIMATED COST OF PRODUCING 100 TONS OF 17 PER CENT Al_2O_3 ALUM SOLUTION.

468 tons 66 deg. Be. sulphuric acid @ $12.50	$5,850.00
265 gross tons bauxite @ $9.90	2,623.50
Lubricating oil	20.00
Steam	100.00
Electric current, 10,000 kw. hr. @ 2 cents.	200.00
Repairs to plant	500.00
Depreciation	600.00
Interest on investment	600.00
Total	$10,493.50

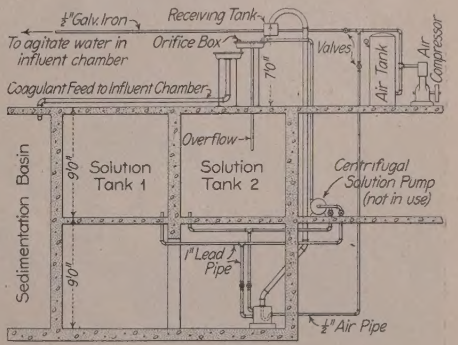
At the Columbus plant it is hardly fair to make any charge for labor because no additional labor is required to operate the new alum plant, consequently the labor item has been omitted in the above estimate. When lump alum was being used here it was necessary to unload it from the cars, sack and weigh it, store it in the storage house, elevate it to the third floor of the head house, stack it up there and finally dissolve it in solution tanks as needed. In addition to all this handling there was three times as much material to move and three times as much storage space required, because, as has already been explained, 1 ton of bauxite will make 3 tons of alum.

Home-Made Alum Airlift Eliminates Pump Corrosion

BY utilizing the airlift principle to pump coagulant solution in the filtration plant at Ottumwa, Iowa, H. A. Brown, superintendent, has eliminated pump corrosion difficulties. Originally the plant was equipped with small centrifugal pumps made of "acid-proof" bronze. They were serviceable only a little more than two years, being so badly eaten away by that time as to render them useless.

To solve the annoying problem the superintendent conceived the idea of using an airlift and installed an experimental pump consisting of a 1¼-in. pipe placed in the solution tank and discharging into a receiving tank over the orifice box. The bottom end of the 1¼-in. pipe was split for about 6 in. to receive the upturned end of a ½-in. air pipe. This crude form of an airlift worked satisfactorily until the solution in the tank was one-third used up. Due to an insufficient submergence, the remainder of the liquid could not be discharged.

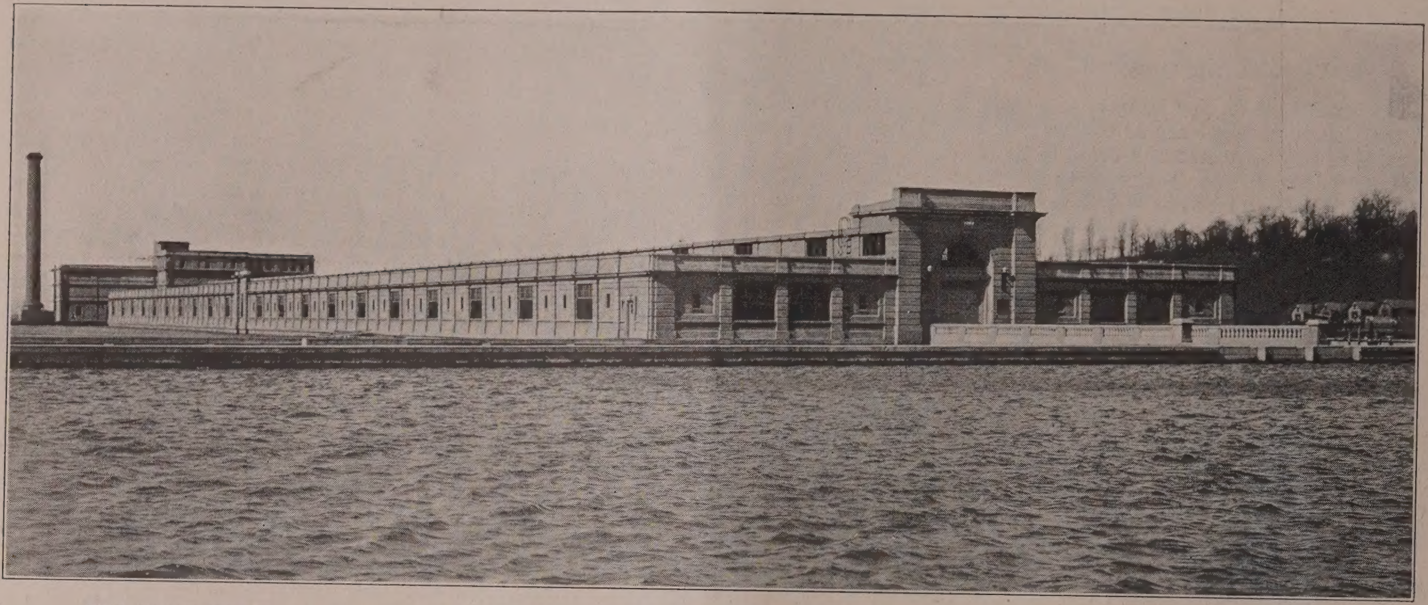
A permanent installation was made by connecting a 12 x 12 x 8-in. lead box, located 9 ft. below the bottom of the solution tanks, with a 1¼-in. lead pipe discharging into the receiving tank. A ½-in. lead air pipe was brought into the side of the box and directed into the 1¼-in. pipe. The solution tank is 9 ft. deep and the receiving tank is 7 ft. above the solution tank thus giving a submergence of from 36 to 72 per cent of the total lift. Under this condition the pump works successfully and the full capacity of the solution tank can be utilized. Air under 5 lb. pressure is employed.



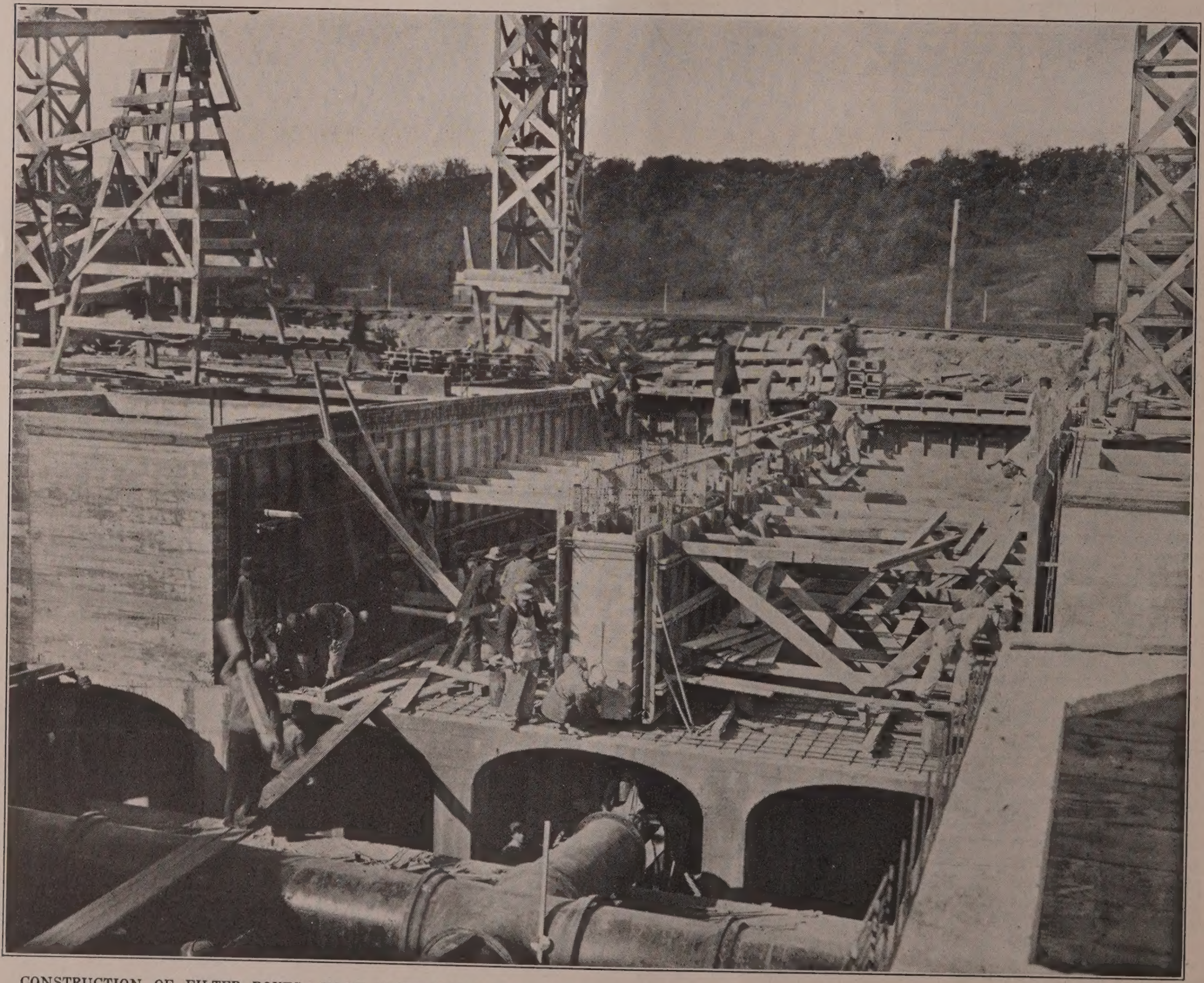
AIRLIFT FOR ALUM AT OTTUMWA

St. Louis Will Operate World's Largest Mechanical Filters Next Week

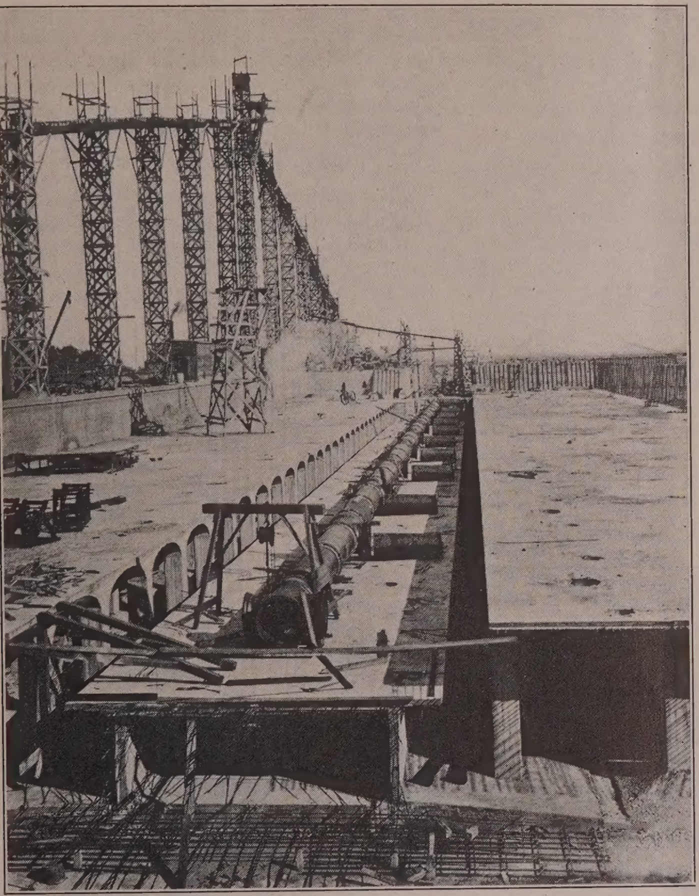
Construction Started in July, 1913—Plant Will Have a Nominal Daily Capacity of 160,000,000 Gallons and Can Be Operated to Deliver 200,000,000 Gallons in 24 Hours—Works Cost $1,300,000



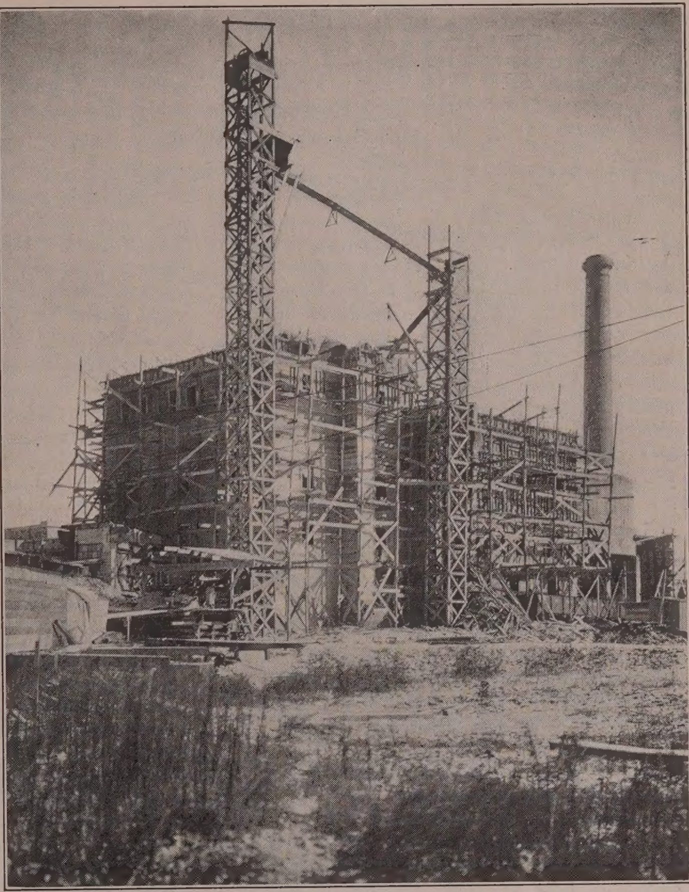
THE FORTY FILTER UNITS ARE CONTAINED IN A REINFORCED-CONCRETE HOUSE, 750 FEET LONG AND 134 FEET WIDE



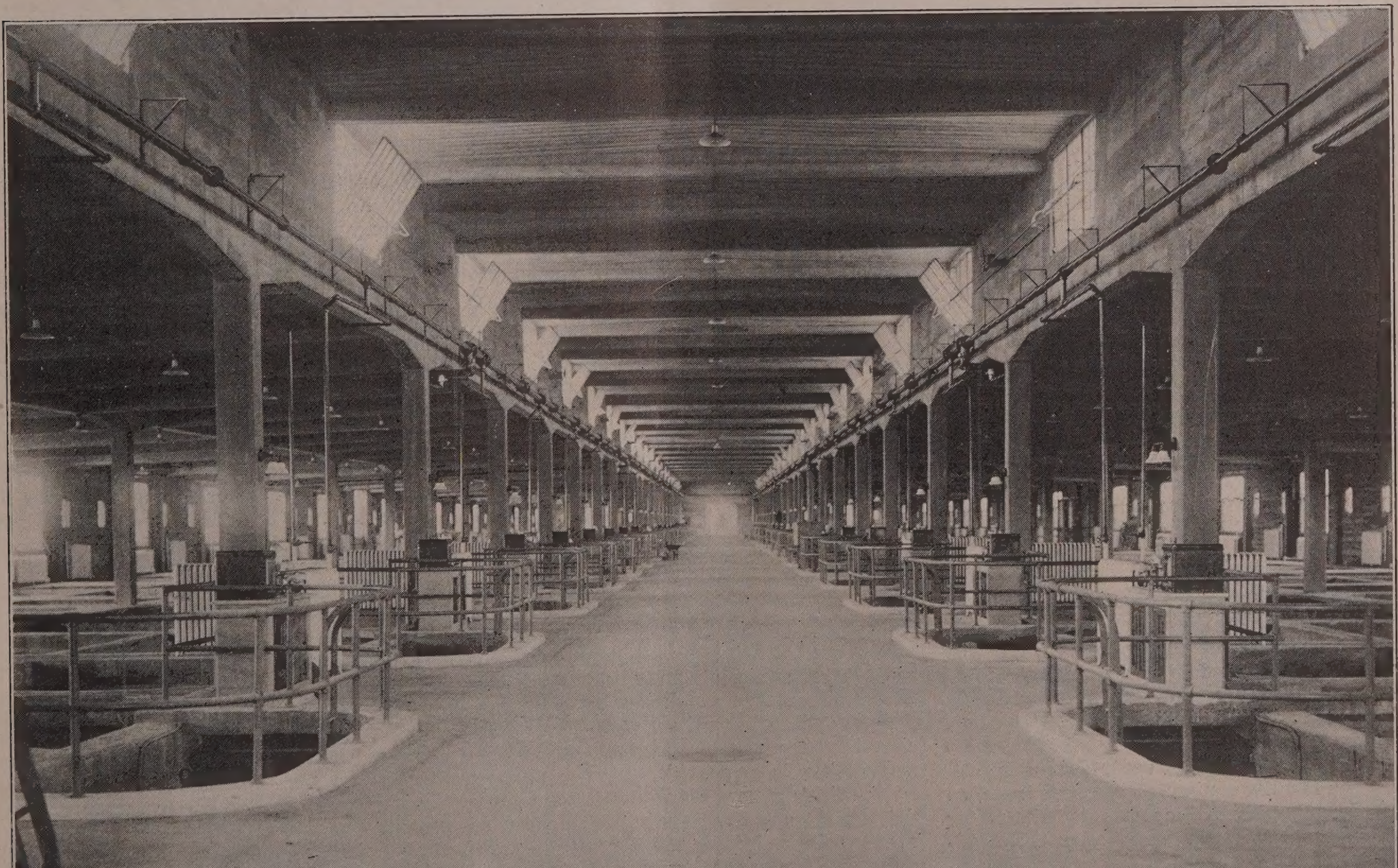
CONSTRUCTION OF FILTER BOXES—EACH UNIT HAS A NET FILTERING AREA OF 1400 SQUARE FEET AND CONTAINS 12 INCHES OF GRAVEL AND 30 INCHES OF SAND, OVER RIDGE-BLOCK STRAINERS



CONCRETE WAS HANDLED BY OVERHEAD SYSTEM



THE HEAD-HOUSE IS A FOUR-STORY STRUCTURE



VIEW ALONG OPERATING FLOOR TWENTY MONTHS AFTER CONSTRUCTION OF THE PLANT WAS STARTED—THE HOUSE COVERS THE ENTIRE AREA OF THE FILTERS

Low-Lift Centrifugal Pumps at Akron Will Operate Under Unusually Varied Conditions

Shop Tests Show 79.6 Per Cent Efficiency for New Filter Plant Single-Stage Unit to Be Driven by Electric Motor or Steam Turbine

By F. A. BARBOUR
Consulting Civil and Sanitary Engineer, Boston

UNUSUAL flexibility in operating methods to meet the varying conditions under which it will be used is the feature of the low-lift centrifugal pumping equipment for delivering water to the coagulating basins of the new filtration plant for the city of Akron, Ohio, which will be completed within a few months. With cheap electric power available part of the time, and steam power obtainable at all times, provision was made for operating the two 20-in., single-stage, pumping units—only one of which will be installed at first—by electric motor, by steam turbine, or by both motor and turbine. While acceptance tests of the pumps have not yet been made, shop tests of one unit developed an efficiency of 79.6 per cent at 600 r.p.m., operating against a head of 30.4 ft. and discharging 9660 gal. per minute.

Features of New Supply

The city's new water supply is taken from the Cuyahoga River above Kent, at a point about 12 miles from Akron. The work, on which E. G. Bradbury, M. Am. Soc. C. E., of Columbus, Ohio, is associated with the author, includes a dam on the river, a rapid sand filter plant of 20,000,000 gal. daily capacity, a pumping station and pumping machinery, 56,000 ft. of 36-in. steel force main, a 20,000,000-gal. distributing reservoir and substantial reinforcement of the street piping system, purchased in 1911 from the water company which previously had supplied the city.

The dam, which is of the hollow, reinforced-concrete type, raises the river level about 20 ft., and impounds about 2,500,000,000 gal. of water. From the dam the water will normally flow by gravity in a 48-in. pipe through the substructure of the head-house of the purification plant to the coagulating basins. The normal water level in these basins is 5 ft. below the crest of the dam, and the inflow is controlled by a valve with hydraulic cylinder actuated by float and pilot valve, so as automatically to maintain a constant level in the basins.

As the watershed of the river at the site of the dam has an area of 208 sq. miles, and the present daily consumption of water by the city is about 12,000,000 gal., the runoff will, except in extreme dry months, be sufficient for some years to come, without drawing from storage. Until the consumption increases to the point where the water above the dam will be drawn down 4 ft., the gravity flow to the coagulating basins, as just described, will be possible. With a greater demand on storage, however, pumping will be required, and accordingly a low-lift equipment has been installed at the pumping station to raise the water from the raw-water well under the head-house of the purification plant to the coagulating basins. These pumps will also be used at times to force the water through an aerator, installed for the purpose of reducing the carbonic acid contents and removing possible vegetable odors from the water.

The particular object of this article is the description of the low-lift pumping apparatus. The dam was built to provide the storage necessary during dry weather periods in the future, but as its construction made available a head of about 20 ft., and during eight months of the year water will be running to waste for a considerable time to come, a hydroelectric plant of 400 hp, consisting of one 300-hp turbine and one 100-hp turbine, driving alternate generators of 250 and 75 kva capacity, respectively, were installed. By this power it is proposed, whenever there is sufficient stream flow, to light the station and purification plant, operate all small motors about the plant, drive the low-lift pumps when lifting water for aeration, and also a high-lift motor-driven centrifugal unit of 3,400,000 gal. daily capacity, by which the purified water will be forced to the distributing reservoir near the city of Akron. The main high-lift pumping apparatus consists of two steam-driven, triple, vertical Tod engines.

Electric and Steam Power Available

With cheap electric power available part of the time, and steam power at all times, provision was therefore made for operating the low-lift pumps, either by steam turbine, or by motor, or by both turbine and motor. The pumping unit consists of a De Laval 100-hp, single-pressure stage, two-velocity stage turbine, double helical gears, a 75-kva alternating General Electric Company generator, and a 20-in. single-stage De Laval centrifugal pump, all directly connected on the same shaft through flexible couplings.

A second unit, identical with the first except that the pump is not at present included, has been provided for the purpose of furnishing power for lighting and for driving the small motors in the purification plant when no hydroelectric power is available. To this second unit a pump can be attached at any time in the future when the increased consumption makes such duplication of the low-lift pumping equipment advisable.

The object of the combined turbo-generator-motor-pump unit is to utilize as much as possible of the power from the hydroelectric plant at all times, and to provide power for the low-lift pumping auxiliary apparatus, and lighting at times when the hydroelectric power is partially or entirely unavailable, or when it is accidentally interrupted.

Varied Operating Conditions

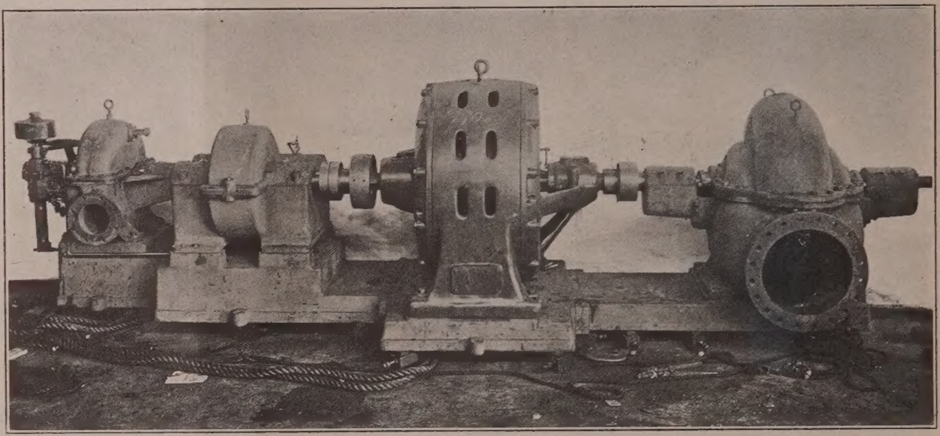
The various conditions under which the apparatus may be used are as follows:

With Pump Disconnected.—(a) As a turbine-driven generator alone to supply the pumping station lights and small power motors.

(b) As a turbine-driven generator to assist the hydroelectric plant, either with or without power factor improvement effect.

(c) As a synchronous condenser "floating" on the line with turbine disconnected for power factor improvement.

(d) As a synchronous condenser "floating" on the line with turbine connected and with governor set so it is "idle" but with turbine throttle open. In either condition (b) or (d) the unit constitutes automatically an emergency generator to maintain the pumping station electric service on failure of the hydroelectric power.



THE PUMPING UNIT CONSISTS OF A STEAM TURBINE, ELECTRIC GENERATOR AND CENTRIFUGAL PUMP ALL DIRECT CONNECTED ON SAME SHAFT THROUGH FLEXIBLE COUPLINGS

With Pump Connected—(e) As a turbine-driven pump alone with generator running "idle" and not connected in electrically. The speed may be varied to suit exact conditions and pump discharge valve will always be left wide open.

(f) As a synchronous motor-driven pump with turbine and gear disconnected. The motor may also be over-excited within its limits of kva capacity for power factor improvement, if desired. Under this condition, and all following conditions, when the motor (or generator) is phased in, it is, of course, impossible to vary the turbine speed, and the pump capacity is consequently to be controlled by its discharge valve.

(g) Ditto, but with turbine connected and "idle," but with its throttle open.

(h) As a turbine-driven pump, but running at synchronous speed with the motor "phased in" but running "idle" and utilized merely as a synchronous condenser "floating" on the line for power factor improvement.

(i) As a combined motor and turbine-driven pump, in which case steam will be utilized merely in an amount necessary to make up the deficiency of power from the hydroelectric plant, the motor being phased in as in (f) and developing more or less power. It can at the same time be over-excited to improve power factor.

(j) As a combined turbine-driven pump

and generator. In this case steam would be utilized to furnish all the power for the pump and in addition to furnish a certain amount of electric power to help out the hydroelectric plant. Under this condition the generator may also be over-excited to a degree to improve station power factor, if desired.

In conditions (g), (h), (i) and (j) it is similarly and automatically an emergency generator up to the limit of the maximum horsepower capacity of its turbine above that being used at the time by the low-head pump.

79.6 PER CENT EFFICIENCY IN SHOP TEST

The acceptance tests of the units have not yet been made, but shop tests of the pumps show the results contained in Table 1.

TABLE 1—TEST OF 20-INCH DE LAVAL SINGLE-STAGE PUMP

Rev. per min.	Total head, feet	Discharge, g.p.m.	Water, hp	Brake, hp	Efficiency
600	29.9	9550	72.1	90.7	79.5
600	30.4	9660	74.2	93.2	79.6
600	35.2	7371	65.6	89.7	73.1
600	39.2	5580	55.2	86.1	64.1

The specified point of best efficiency is against a head of 30 ft., but for short periods of extreme low water this head may be exceeded. In the shop test of pumps the discharge was measured by a calibrated nozzle and pitot tube and the input by the power consumption of a direct-current motor of known efficiency.

STEAM CONSUMPTION OF TURBINE

The turbines are to operate either condensing or non-condensing—steam pressure to be 170 lb. and superheat 100 deg. Fahr.—and the acceptance tests to fulfil guarantees will be made under these contract conditions.

Preliminary tests of the turbines were run at the shop without superheat, and with moisture varying from 1.0 to 4.0 per cent. Steam consumption was determined by measuring the condensate in a calibrated tank and the output by the current generated by the 75 kva generators.

The last column of Table 2 shows the steam consumption of one of the turbines per brake-horsepower hour, calculated to approximate contract conditions by correcting the observed steam consumption under shop test conditions for double the percentage of moisture present, and allowing 1 per cent reduction for each 10 per cent of superheat, specified by the contract, but not available at the shop.

TABLE 2—TEST OF 100-HORSEPOWER STEAM TURBINE

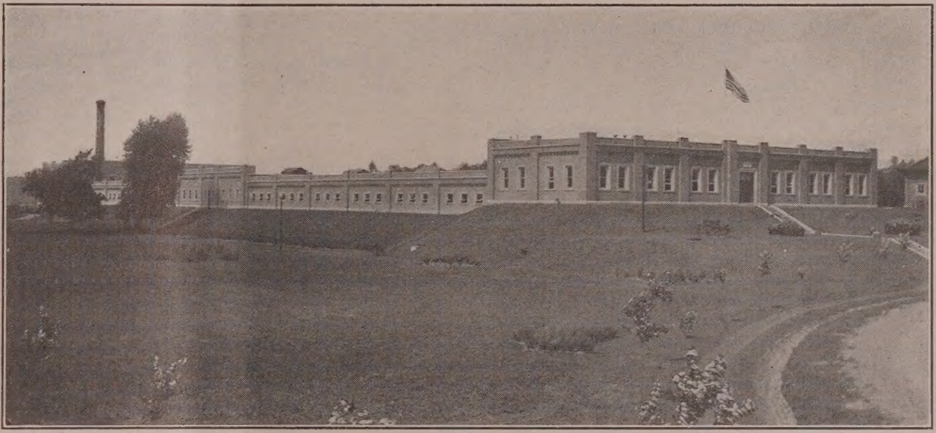
Rev. per min.	Steam pressure	Back pressure or vacuum	Brake hp	Pounds steam per Brake-hp hour calculated to contract conditions
Non-condensing:				
600	170	5 lb.	101.0	31.8
600	170	5 lb.	77.4	32.3
600	175	5 lb.	53.0	35.0
Condensing:				
595.5	175.2	26 in.	102.0	18.45
600	175	26 3/16 in.	75.0	20.35
600	177	26 ⅛ in.	62.0	22.4
599	177	26 in.	52.9	23.3

It is anticipated that in the operation of the station the various conditions under which the turbo-generator unit may be run, as described above, will merge into one another, depending on the variations in the lighting and small motor load, the high-lift pump load, and on the water available at the hydroelectric plant. When the water power obtainable is about equal to the average total combined load of high- and low-lift pumps, small motors and station lighting, the turbo-generator will act as an automatic stabilizer. It will run as a motor-driven pump at periods when the combined load is less than this average, and automatically help out by steam when the total combined load is greater than this average, and under all of these conditions it will be of more or less assistance in power factor improvement.

Brass Screen Between Sand and Gravel Eliminated in Cincinnati Filter Reconstruction

Breaks Caused by Corrosion Necessitated Frequent and Costly Repairs —New Plan Uses Graded Layer of Heavier Gravel Without Screen

By J. W. ELLMS
Superintendent of Filtration, Cincinnati Waterworks



CINCINNATI WATER PURIFICATION PLANT WHERE FILTER BEDS HAVE BEEN RECONSTRUCTED, ELIMINATING BRASS WIRE SCREEN

BREAKS in the brass wire-cloth originally laid between the sand and gravel layers of the filter beds at Cincinnati necessitated the reconstruction of the units last year. Corrosion was the cause of the trouble. The expense of constant repair work on the screen and its continued deterioration led to experimental work to find a remedy for the difficulty which would be both practical and less expensive than the continued renewal of the screen. The problem involved a number of features which had to do with the form of strainer system as originally constructed in the filters, and with the high velocity method of washing in vogue at this plant.

An experimental filter was constructed, having a filtering area of 9 sq. ft., and with it a series of experiments was made which provided the necessary information for determining the feasibility of the tentative plans adopted. On the completion of the experiments, one of the large filters of the plant was reconstructed along the lines developed by the experimental work, and was immediately placed in operation. This filter has been in service nearly two years and has given excellent results.

PLAN OF RECONSTRUCTION

The plan of reconstruction consisted in removing the filtering material and brass wire-screen from the filter tank, and rebuilding the bed with a graded layer of heavier gravel than was first used, omitting the screen between the sand and gravel, and replacing the sand. As these filter units are quite large, having a filtering area of 1400 sq. ft., and containing 130 cu. yd. of sand and 24 cu. yd. of gravel as originally laid, the economical handling of this material for twenty-eight filters became important. In the reconstruction the gravel layer in each filter was regraded and deepened by about 6 in. This change necessitated the handling of about 26 cu. yd. more of gravel for each filter in addition to that originally used.

It was planned to take advantage of the opportunity afforded in rebuilding the beds to examine the condition of the strainer plates and the channels underneath them in order to see how seven years of service had affected them. This work required the removal in some filters of quite a number of the strainer plates. Usually a row of plates over each set of riser pipes and the plates at both ends of the tank were taken out. The caps on the headers, into which the riser pipes connect, were also removed, permitting an examination and thorough washing out of the channels and piping. Hook bolts, which had been broken, were replaced, and the holes of the strainer plates were gone over and the closed perforations opened.

The gravel layer as originally built and as reconstructed are shown in Table 1.

TABLE 1—GRAVEL LAYER AS ORIGINALLY BUILT AND AS RECONSTRUCTED

As Originally Constructed			As Reconstructed		
Depth of layer, inches	Gravel passing screen with mesh of, inches	Gravel retained on screen with mesh of, inches	Depth of layer, inches	Gravel passing screen with mesh of, inches	Gravel retained on screen with mesh of, inches
1	1	½	2	..	1
7	½	1/10	2	1	¾
½	1/10	1/12	3	¾	½
..	..	..	4	½	¼
..	..	..	3	¼	..

The sand originally used had an effective size of 0.34 mm., and a uniformity coefficient of 1.5 to 1.6. The sand has become somewhat coarser by washing, and now has an effective size of 0.38 mm. and a uniformity coefficient of 1.35.

Sand Handled by Ejector

In order to handle the sand as cheaply as possible a centrifugal pump, driven by a 20-hp, 220-volt direct-current motor, was installed. The pump and motor were placed on the motor gallery floor of the filter house. The pump takes water from the 36-in. wash-water pipe in the pipe gallery. The pump will discharge 180 gal. a minute under a pressure of 100 lb. per square inch at the pump. The water is piped to a hose-stand at the operating floor level, from which point 2½-in. woven cotton rubber-lined hose is used to carry the water to the sand ejector.

The sand ejector is of the usual portable type, and is provided with a flat iron base, so that it may rest upon the sand. An extra irrigating pipe is attached to the top of the hopper in order to cause the sand to drop down more readily into the throat of the hopper when sand is being rapidly shoveled into it. The sand is discharged through a 3-in. rubber hose into a galvanized iron pocket, supported on its side between two waste-water troughs. The sand is discharged in this manner so as not to disturb the gravel layer, which would be the case if the end of the discharge pipe should point directly toward or be laid upon the surface of the gravel.

Sequence of Operations

The general plan of procedure in reconstructing the filter beds has been as follows:

At one end of the plant the sand was removed by hand from one-half of a filter and stored on a platform. This was done for the purpose of being able to eject the sand from one-half of the adjoining filter into the reconstructed half of the first filter, and thereby make one handling of the sand provide for removal and refilling of the beds. This plan has been successfully carried out, and has made the cost of handling sand quite low.

After taking out the sand from one side of the filter tank the brass wire screen is quickly removed. The gravel is then shoveled into bags, hoisted to the top of the tank and wheeled on bag trucks to the middle of the filter house, where sufficient floor space permits it to be spread out and dried. After drying the gravel is screened and is then ready to be used in rebuilding the gravel layer.

As soon as the gravel has been removed from one side of the filter tank the troughs and tops of the strainer plates are brushed off as clean as possible, and the plates removed over the four sets of riser pipes and at each end of the tank. At the same time the caps on the headers for the riser pipes underneath this half of the filter tank are taken off. This permits an examination of the channels, riser pipes and headers, and their thorough washing out by means of a hose stream and by flushing back with wash-water from the wash-water pipe line. In order to prevent sand or gravel which may be in the channels from being washed down through the riser pipes into the main effluent pipe, a semi-circular piece of galvanized iron is pushed into each header until it covers the opening of the tee through which water from the header reaches the effluent pipe. Anything washed down the riser pipes thus passes out at the ends of the headers. Flushing back with wash-water through the main effluent pipe is always done after removing the semi-circular pieces of iron mentioned above, and while the caps of the headers are off. Deposits or material that may have gotten into the main effluent pipe are thus removed. The caps on the headers are then replaced.

Following the cleaning of the channels and pipe, the strainer plates, which were removed, are replaced. After cementing them in place and allowing time for the cement to harden the strainer plate openings of the entire half of the filter are punched out with a small punch. Each strainer plate hook bolt is examined and tested, and, if found broken, is replaced. In some filters a great many hook bolts have been found broken, while in others only a very few.

For rebuilding the gravel beds it is necessary to buy washed Ohio River gravel and to screen out from it the material of the various sizes desired. This screening is done outside of the filter plant building, and when material is needed the different sizes of gravel are placed in bags and brought by a wagon to the center of the filter house. From this point it is carried on bag trucks to the filter bed under construction. The new gravel, together with the rescreened material taken from the filter, is quickly placed. The men bringing the gravel to the filter dump it over into the tank, while men below spread it with rakes and level it up. Great care is taken to make the gravel layers of the various sizes uniform for the depths determined as desirable by the experimental work.

Table 2.—Cost of Reconstructing Four Filter Beds

Filter	No. 4	No. 6	No. 8	No. 12
Removing old gravel	$34.50	$35.50	$38.25	$38.75
Screening old gravel	33.25	33.50	34.00	36.00
Removing strainer plates	6.75	6.50	7.50	6.50
Cleaning strainer plates	17.50	19.50	18.50	18.75
Cleaning filtered water channels and pipes	2.75	4.50	3.50	6.00
Replacing strainer plates	14.50	17.50	18.50	17.50
Replacing gravel	35.75	36.50	37.00	36.50
Refilling bed with sand	14.00	13.50	11.00	12.00
Operating pump for sand ejector	2.16	2.16	1.76	1.92
Removing and replacing caps on headers	15.00	13.50	10.50	13.75
Screening new gravel at pile	13.19	13.19	13.19	13.19
Loading and unloading gravel for hauling	23.06	23.06	23.06	23.06
Hauling with team	8.50	8.50	8.50	8.50
Value of 26 cu. yd. of gravel added to bed	54.00	54.00	54.00	54.00
Total	$274.91	$284.41	$279.26	$286.42

Average cost per filter, $280.50.

Refilling Beds

After the gravel bed is constructed there only remains the filling of the bed with sand, which is carried out as previously described by ejecting the sand from one side of an adjoining filter onto the reconstructed gravel layer of the first filter. In this way two filters are necessarily out of service at one time, but economy in handling the sand is effected. In discharging the sand into the reconstructed filter bed, the sand is made considerably cleaner, but of course carries the dirty wash-water with it. In order to prevent the gravel becoming fouled with this material, the filter tank is carefully filled from below with clean wash-water before starting to eject sand into it. During the time the sand is being discharged into the filter tank, a slight amount of wash-water is permitted to come up from below through the gravel and the sand. This carries the dirty water over the waste troughs into the sewer. The sand is also leveled by opening the wash-water valve an inch or two for about a minute four or five times during the filling of the bed. This also aids in cleaning up the sand.

It is of interest to note that no bent strainer plates have thus far been found. Even when hook bolts are broken the cementing of the plates at the sides and the lap of each plate appear sufficient to hold them in place. It is the writer's belief that many of the broken hook bolts were overstrained when first placed by turning the nut down so far as to put too great a tension on the hook, and thus started a small crack, which, by the corrosive action of the water and the pressure of the wash-water during washing, became deeper and deeper until the hook finally broke. Many bolts have been found partially broken, and practically all the fractures occur at or near the bend of the hook.

Pipe Obstructions Found

Pieces of wood, trowels and scrapers have been found in the pipe headers underneath the filters. At the time of building the plant, wooden plugs were placed in the riser pipes before casting the wedge-shaped blocks which form the filtered water channels. Some of the plugs have been found still in place. Sand and gravel, which could not be accounted for by any displaced strainer plates and which must have been left in the large pipes of the plant during construction, were also found under the strainer plates. This material and the wooden plugs account in some cases for poor washing. The finding of this material is an illuminating sidelight on the carelessness of workmen and the laxity of inspectors, to say the least.

Cost of Work

The cost of this reconstruction work is being kept in detail and Table 2 shows the cost of rebuilding the beds and making the necessary repairs on four of the filters.

On the basis of the average cost for rebuilding these four filter beds, a cost for the twenty-eight beds will be $7,854. To this should be added approximately $650 for one-half of foreman's time for looking after the work during the sixteen months required to reconstruct all of the beds. This makes a total cost of practically $8,500. The estimated cost of rebuilding the beds the same as before with new brass wire-cloth was over $15,000. It was further estimated that any attempt to improve on the original imperfect method of fastening the brass wire screen by using brass strips to hold it down would have cost from $5,000 to $10,000 in addition to the above mentioned amount, depending on the spacing of the brass strips. This would have made the total cost from $20,000 to $25,000, as compared with $8,500 by the method adopted.

Baltimore Filters Abound in Useful Hints on Concrete Construction and Design

Wet Concrete Hindered Screeding on Slopes—Steel Forms at First Caused Trouble but Gave Satisfaction When Remodeled—Cypress Strips Used at Joints

By JAMES W. ARMSTRONG
Engineer, Filtration Division, Baltimore Water Department

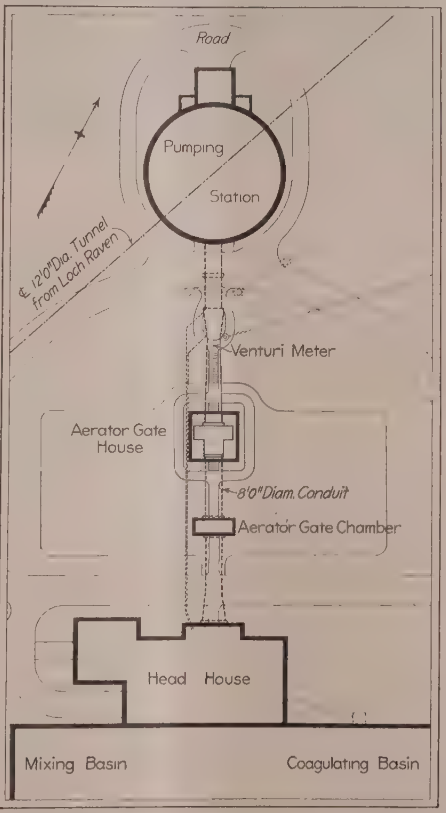
IN the construction of Baltimore's new mechanical filtration plant at Lake Montebello a number of useful lessons have been learned, particularly with reference to the mixing and placing of concrete, the use of steel forms for columns and groined arches and joints in floor blocks. The design, also, involved special features, among which were the handling of wash-water in settling reservoirs, the drainage system of the plant, effluent piping details, head-house arrangement, and pumping station. As described in the Engineering Record of May 9, 1914, page 520, the works, which are now practically completed, include thirty-two filter units, each with a daily capacity of 4,000,000 gal., a baffled mixing chamber, two coagulating basins, a covered filtered water reservoir, two dams forming wash-water sedimentation reservoirs, a head-house and pumping station.

GENERAL FEATURES OF DESIGN

The Montebello filters at Baltimore are built upon ground whose topography limited their location to rather narrow confines and necessitated the removal of a large amount of earth. The topography is also responsible for the placing of the filtered water reservoirs on an angle to the main axis of the plant, as it was thought unwise to build any of the structures on filled ground. Economy in the use of ground and also in the use of materials pointed to the desirability of compactness of design. This was accomplished by placing the various structures adjacent to one another and making as many walls as possible common to two different structures.

The filters were arranged approximately in a square in order to get a large basin under them with the shortest length of outer wall. The center passage acts as a division wall between basins and at the same time forms conduits for water and drainage. It is coincident with the main axis of the plant and by placing the intake shaft at its intersection with the existing tunnel that conveys the water supply from Loch Raven, a short connecting conduit was obtained.

About 50,000 cu. yd. of concrete were used in the construction of the filtration plant and as most of it was designed to withstand water pressure, or was used in structures which are heavily loaded, a 1:2:4 mixture was employed, except in the groined arches, where the proportions were 1:2½:5. On account of delays which frequently occur in construction work of this character only slow setting cements were used. The time of initial set ranged between 2 and 5 hours and of hard set between 3 and 7 hours.



LAYOUT OF WORKS AUXILIARY TO THE BALTIMORE FILTERS

The filters, not shown in the drawing, are located at the south end of the mixing basin.

Both sand and gravel were of good quality and were well graded in size, but as most of it came from the harbor more or less trouble was experienced with dirt, mud balls occurring in the sand. It was required that all sand be screened and most of the gravel washed on the job.

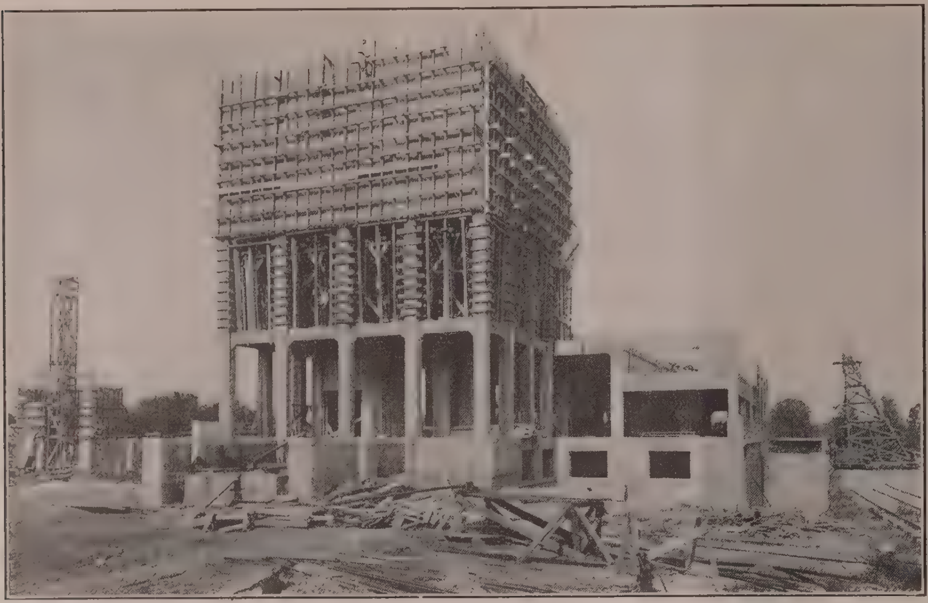
EXPERIENCES WITH WET CONCRETE

Generally the concrete was mixed wet enough to flow in the forms and around the steel reinforcement, but was not made wet enough to permit the pebbles to separate from the mortar. When concrete was screeded to a finished or sloping surface much drier mixtures were used and it became harder to secure the best results. On one of the contracts frequent disputes arose between the contractor's men and the inspectors regarding the proper amount of water to be added to concrete to be used on sloping surfaces. In the early stages of the work the concrete was placed in the groined arches over the filtered water reservoirs through a long line of spouts and in order to get it to flow it became necessary to mix it very wet. The impossibility of screeding it to the required slope soon became apparent and an attempt was made to use forms for shaping the depression over the columns, but much difficulty was experienced in holding the wet concrete to the proper slope between the edge of the form and the crown of the arch. In an effort to do so it was worked over a good many times.

It was recently discovered that some of the arches, after being in place nearly a year, were apparently of poor quality, as a light blow with a pick would separate the gravel from the mortar. Investigation proved that the trouble was located in the zone where difficulty had been experienced in forming, the concrete above and below being of much better quality. These facts were taken to indicate that certain portions of the concrete had been injured by excessive working and the defective arches

DEPTH OF PUMP PIT NECESSITATED HEAVY WALL SECTIONS

FILTERED WATER RESERVOIR IS COVERED BY CONCRETE GROINS



AT THE HEAD-HOUSE THERE IS A TOWER 80 FEET HIGH CONTAINING THE CHEMICAL STORAGE BINS

were reinforced. The groined arches which supported the filters were reinforced as a unit in both directions, the largest section of which measured about 106 ft. x 256 ft. No cracks have been observed in the groins so far, but during the hot weather last summer, before the filter boxes were built, slight cracks were observed in some of the columns at the spring line of the arches. This was taken to indicate movement due to expansion of the arches above. Most of these cracks have disappeared, although some of them are still visible on close inspection. Although most of the concrete work is designed to withstand the pressure of water, no water-proofing compounds were employed, as good workmanship and materials were relied upon for securing watertight work.

Steel Forms for Groins

Both wooden and steel forms were used in the construction of the filtration plant. In the filtered water reservoirs steel forms were used for the groined arches, walls and columns. The steel forms for the columns proved an utter failure and were only set up once, as the length of time taken to erect and wreck them was so great as to make them entirely impractical. The steel forms for the groins were a little better, but were still far from being a success. They were made by constructing longitudinal barrels which extended for a distance of about three groins, two sides of the groin in each case being formed by this barrel. The remaining sides were formed by inserting triangular-shaped filler pieces, one end of which rested on the column, from which they were curved upward to the crown of the arch. These forms proved very difficult to erect and move, and after a few trials they were abandoned and the remainder of the groined arches in the filtered water reservoirs were constructed with wooden forms.

The wall forms were also made of steel and were entirely successful in their operation. They were suspended from a structural steel frame which traveled on a track supported on 12 x 12-in. timbers, one rail being laid on each side of the wall. On a later contract, that for the filters, steel groined arch forms were again used and with entire success. The forms were constructed on an entirely different plan from those used in the filtered water reservoirs. They were supported on steel travellers and were made collapsible by the removal of filler pieces which fit in between the columns. The operation of these forms was very satisfactory, as the concrete surfaces, after the steel forms had been removed, were unusually smooth and glistened in the light. Steel forms were also used for forming the water conduit in the filter galleries, but with the exceptions named, all forms used in the construction of the work were made of wood.

There were over 2,000,000 lb. of deformed reinforcing bars used in the construction of the filtration plant, the major portion being twisted bars. Mild steel twisted bars were originally specified on account of the increase of elastic limit due to the twisting, but as there was some opposition to the specifications on the part of some of the deformed bar companies it was decided to admit hard grade steel bars having an ultimate tensile strength of 80,000 lb. and a yield point of 50,000 lb. Bars under ¾ in. were to bend cold without fracture 180 deg. on two diameters and those ¾ in. and upward were to bend cold 180 deg. on three diameters. At first the manufacturers objected to the bending test in these specifications, but finally accepted the conditions of the specifications and met the tests.

Construction and Expansion Joints

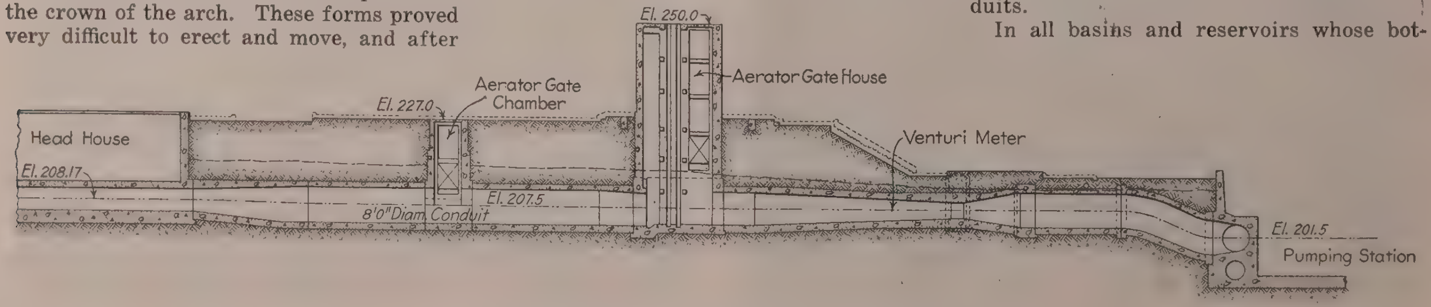
As a rule construction joints were shown upon the drawings and were placed at proper intervals for securing convenient pourings. Except in two or three instances where it became necessary to complete certain portions of the concrete work in one operation no section was made larger than could be conveniently poured in a working day of 10 hours. In floor blocks, where no reinforcement was used, 20 ft. was the limit placed for the length of a single block. In walls, joints were placed about 30 ft. apart and where they were built in one or more lifts all sections were stopped on the same vertical line. No cracks of any description have as yet been observed between joints in any of the wall sections.

The filter tanks, 32 x 53 ft. outside dimensions, were reinforced and poured as units. They were supported on the reinforced arches forming the roof of the basin beneath, and were poured in hot weather. When cooler weather came it was found that in some cases the bond of the concrete between adjacent filter tanks was sufficient to prevent the slight separation of the walls which was anticipated, but instead very slight cracks occurred in the walks that tied together the tank walls.

Pouring Venturi Meter

In pouring the 8-ft. Venturi meter, which is about 70 ft. long, it was thought best to complete it in one operation, but as there is a marked downward slope in both directions from the throat it was decided to prevent any troublesome cracks by placing the longitudinal reinforcement in short lengths without lapping it at the ends. In order to prevent leakage in case a crack occurred at the ends of any of the bars circular steel plates were placed around the meter at each point where the bars separated. Wherever it became necessary to stop work on horizontal lines carefully made keyways were formed. When vertical joints occurred no keyways were formed, but 12 x ¼-in. steel plates were extended the full height of the wall, or section, and where the wall rested on the earth the plate extended below the wall into a concrete pocket, which forms a water cutoff and also prevents water from following down the plate and getting under the wall. When conduit sections adjoined one another the steel plates entirely surrounded the conduit and were fastened at the ends by countersunk rivets. This method was used for both circular and rectangular conduits.

In all basins and reservoirs whose bot-



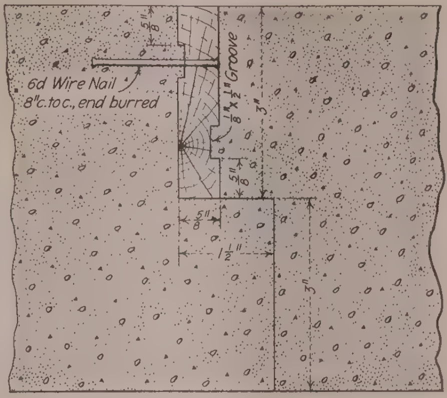
FROM THE PUMPING STATION THE WATER FLOWS THROUGH A VENTURI METER, AERATOR GATE-HOUSE, HEAD-HOUSE, MIXING BASIN, COAGULATING BASINS AND THENCE TO THE FILTERS toms are to be continuously covered with water, the floor blocks were surrounded by an offset joint 1½ in. wide, placed on the center line of the slab. A well seasoned cypress strip was secured to the vertical face of the upper half of all the joints. Upon becoming water-soaked, this strip will swell slightly and compensate for the contraction of the floor slabs due to the cooling effect of the water. The strips were made and attached as shown in the drawing. Occasionally some of them would become loosened by the carelessness of workmen in removing forms, but otherwise little trouble was experienced in handling them.

On the concrete facing of dam 1, built to form a wash-water settling basin, the cypress strips were not used, as they would be exposed to alternate wetting and drying, but instead an offset joint of 3 in. was made at the center of the 6-in. slab and coated heavily with Min-Wax, which is more or less plastic under various changes in temperature.

The gutters in the coagulating basins were built in one operation up to the level of the under side of the floor slab and were troweled smooth on top. The upper section of the gutters was formed by the 6-in. floor slab and the joint at its bottom line permitted the expansion and contraction of the floor without crushing the sides of the gutter, as has occurred in certain other reservoirs. Most of these gutters were built during hot weather and in some places where the workmen were a little careless in finishing the tops a crack appeared on the line of their outer edge when the weather became cooler.

STORAGE BASIN FOR WASH-WATER

The disposal of wash-water and sludge from the basins offered the most serious objection to Montebello as a site for the filter plant. To build a sewer connecting the filters with the nearest existing sewer entering the upper harbor would cost $90,000 and presented the further difficulty of silting up the harbor. Advantage was taken of a ravine north of the filter plant to form a storage basin for settling and clarifying the wash-water before admitting it to Herring Run, a small stream used as a partial water supply for Baltimore County. The water level of this basin is sufficiently low to permit the drainage by gravity of the entire filter plant with the exception of the pump pit and the filtered water reservoirs which can be drained in another direction.



CYPRESS STRIPS AT FLOOR BLOCK JOINTS

When water-soaked they swell and compensate for contraction of floor slabs, due to cooling effect of water

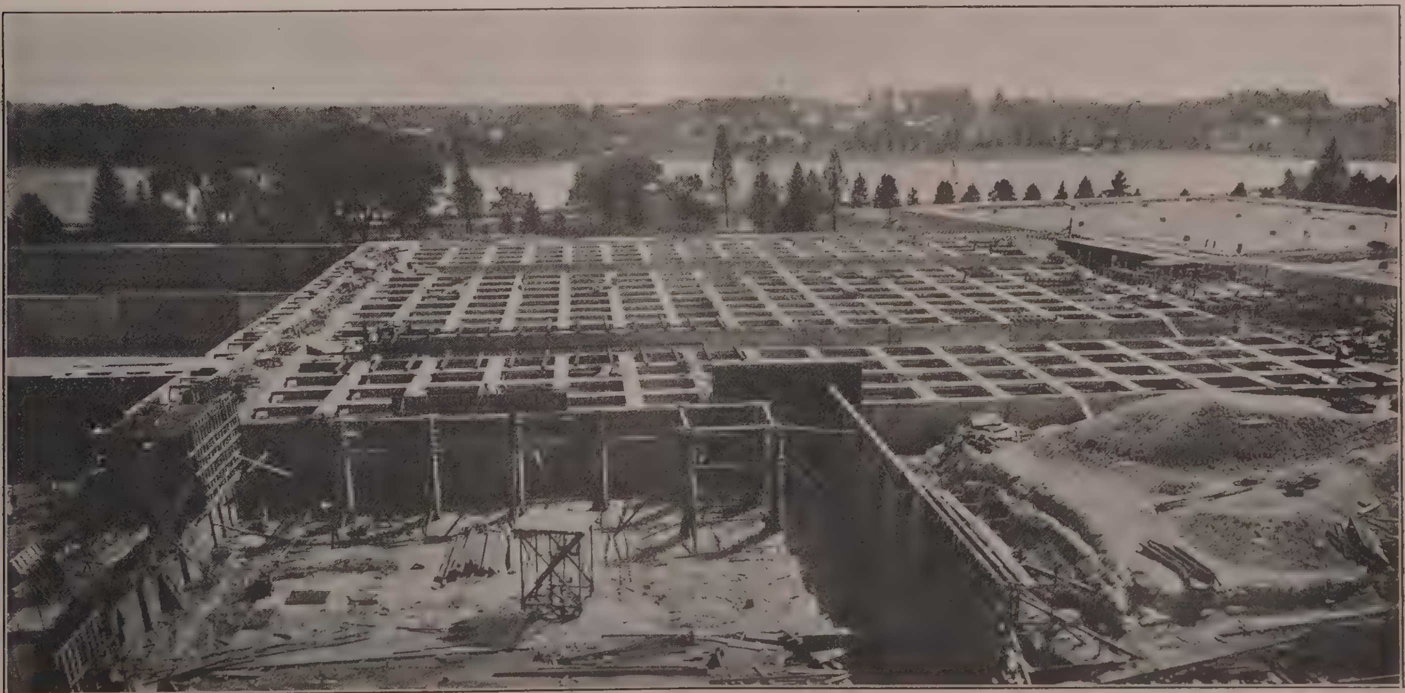
DRAINAGE SYSTEM FOR FILTERS

A carefully planned drainage system is of especial importance to a large filter plant. Direct trunk lines with short branches are desirable both for economy and convenience in operation. The drainage system of the Baltimore plant consists of a main drain and two laterals which permit the water or sludge from all the basins, buildings, filters and conduits that are tributary to it to be admitted by simply opening a sluice-gate or a valve connected by a short length of pipe. The main drain is made large enough to remove the wash-water from the two filters simultaneously, and is located directly under the center passage until it reaches a point near the head-house, where it branches and is carried as an independent 48-in. circular conduit to the point of outlet. The laterals are laid under the water conduits and extend the full length of the filter galleries. These drains are designed to receive the water of only one wash at one time, but they each serve sixteen filter units, the water being admitted through 30-in. pipes. Both the laterals and that portion of the main drain under the center passage are made integral with the structures above them and have their bottoms made V-shaped. The shape of the bottom and the excellent fall of 0.5 per cent obtained in the main drain permit a large amount of sediment to be carried with a small volume of water. An effort has been made to keep the floors of the pipe galleries free from water by giving them a slope toward the water conduits, and then leading the water through a small gutter to each end of the gallery into a sump. From the sump water is admitted to the drain through a specially designed float valve which permits the passage of water into the drain, but prevents back-water from entering the sump.

EFFLUENT PIPING DETAILS

Instead of turning the filter effluent directly into the basins, as is done in many filter plants, it is turned into the lower conduit and led to the east end of the filters, where it can be turned into the basin on either side of the gallery. This arrangement enables an attendant to enter any one of the basins for repairs and still operate all the filters above the basin. The complete drainage of any basin can be effected by opening a 12-in. valve in the pipe gallery. In order to clean one of the coagulating basins it becomes necessary to empty it.

Water for cleansing is drawn from two sources: That for flushing is raw water taken from the stilling chamber of the head-house through a 12-in. pipe and is discharged directly into a gutter laid to a grade of 1.83 per cent, one gutter being located in the center of each half of each basin. This forms a carrying medium for the sludge which will be washed into the gutter by streams of water from fire hose, connections for which are provided on a



ECONOMY IN GROUND SPACE AND MATERIALS RESULTED IN FILTER PLANT OF UNUSUALLY COMPACT DESIGN

4-in. water main secured along the baffle walls.

HEAD-HOUSE

The head-house was planned for convenience in operation and with a view to keeping the building clean and free from dust due to the handling of chemicals. In the basement are located two boilers to be used in connection with a vacuum steam heating system. Beneath each of the boilers an ash receiver has been placed, each holding twelve cans. These ash cans can be revolved, one can being kept continuously under the boiler so that no ashes need be taken into the boiler room except as the cans are being removed from the building. The basement also contains a vacuum cleaner, an air compressor, machinery for an automatic refrigerating plant, a ventilating fan, a lime crusher, and the machinery for operating the freight elevator. On the ground floor are located the laboratories, which are fully equipped with all necessary devices, the chemical controllers and the locker and toilet rooms. The second floor above the ground is used for mixing and handling chemicals, and on that floor are located the lime mixers, the various recording gages for the chemical solution tanks, the trolley system for conveying chemicals to the tanks. On the northwest corner of the building, a tower about 40 ft. square is erected, which rises 80 ft. above the ground. This tower has fifteen bins for storing chemicals which will hold about two carloads each. Extending the full height of the tower is a shaft in which is placed the freight elevator of 6 tons' capacity, and the bucket elevator for handling chemicals.

PUMPING STATION

In order to take as much advantage as possible of the storage capacity of the new impounding reservoir at Loch Raven, it was decided to place the floor of the pump pit 23 ft. below the surrounding ground level, making it 6 in. above the crest of the Loch Raven dam. The pumping station is built circular in plan, 84 ft. in diameter, with its outer walls concentric with the intake shaft, which is 16 ft. in inside diameter. The intake shaft is located with its center over the axis of the 12 ft. tunnel that brings the present city water supply from Loch Raven. The bottom of this tunnel is 49 ft. below the floor of the pump pit or 72 ft. below the surrounding ground level.

The depth of earth excavation necessitated the use of heavy wall sections, the lower portion of which was used for forming a 6 ft. 6 in. circular conduit for receiving the discharge from the centrifugal pumps. This conduit entirely surrounds the pumping station and feeds from both directions the 8 ft. conduit supplying the filter plant. Provision is also made for an outlet for a future filter plant. By making the pumping station circular the benefit of an arch was secured for resisting the pressure of the outside earth, and by placing the 6 ft. 6 in. discharge conduit in the outer wall, it is possible to supply both the present and a future filter plant from the existing conduit, as water from the pumps can flow to each outlet in two different directions.

THIRTY STATES at the beginning of the present year had on their statute books laws providing for the employment of State prisoners in road building.

Dry-Feed Apparatus Solves Ithaca's Coagulant Problem

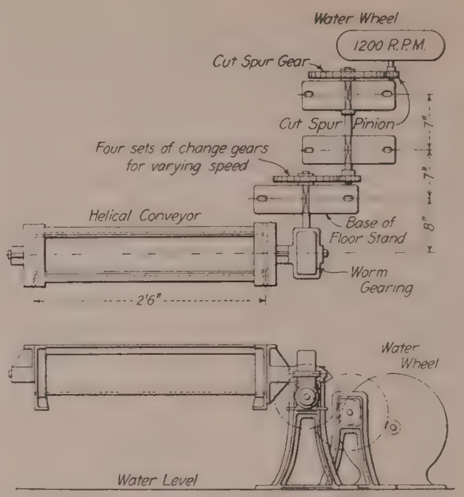
Helical Conveyor with Four Sets of Gears for Variable Speed Regulation Installed at City Filters

By HENRY N. OGDEN
Professor of Sanitary Engineering, Cornell University

DIFFICULTIES in the operation of the municipal filtration plant at Ithaca, N. Y., have been overcome by the substitution of a dry-feed coagulant apparatus for the original equipment which applied the chemical in solution. There are two inherent objections to the method of applying coagulant in solution from a constant-level tank through a graduated orifice at a specified rate. One is that the orifice, even if made of hard rubber, becomes corroded or accumulates deposits on its edges so that the original calibration does not remain true and frequent re-calibration is necessary if the graduation of the stem is to be depended on. The second difficulty is that the pipe used to convey the solution from the orifice to the raw water also becomes corroded and filled up. All of these difficulties have been experienced at the Ithaca filters, and when, last summer, the writer became officially interested in the operation of this plant, the condition of the alum feed most imperatively needed attention.

OPERATING DIFFICULTIES

The solution tanks were under the floor and held about 2000 gal. In the tanks, which were in duplicate, 600 lb. of alum were dissolved, and this solution was pumped by means of a small waterwheel, direct-connected with a rotary pump, into the constant level tank. The wheel and pump for one tank can be seen under the window in the photograph. This pumping plant had outlived its usefulness. It required several minutes to start the pump and it was not uncommon for the operator to keep the orifice tank full for hours at a time by bailing, because he could not start the pump, particularly when the solution tank became nearly empty. After foot-valves had been provided, joints made tight, and some brass pipe substituted for some of the rubber pipe that leaked, troubles ceased for a while, but six months later they began again and about that time also the concrete solution tanks commenced to leak so that there was free communication between the two tanks. The intervening wall is 12 in. thick and seems to have been eaten through by the alum solution.



FOUR SETS OF CHANGE GEARS MAY BE INTRODUCED BETWEEN THE WATERWHEEL AND THE HELICAL CONVEYOR TO VARY THE RATE OF THE COAGULANT FEED

HELICAL CONVEYOR AND GEARS

After considering the possibilities of repairing or lining the tanks, and the difficulties of keeping the pumps in service, the writer advised the installation of a dry-feed apparatus that has since been put into successful use. A helical conveyor, 4 in. in diameter, was bought and operated by hand to find the speed necessary to discharge daily from 300 to 2000 lb. of alum, the range of amounts used. These speeds were from ½ to 3 r.p.m. It was assumed that the waterwheel speed could not be varied sufficiently to give such variation and there-

THE WASTE-WATER FROM THE WHEEL WHICH RUNS THE GEARS IS DISCHARGED UPWARD INTO A CENTRAL BOX WHERE THE DOSE OF ALUM IS APPLIED fore in the train of gears a pair of gears was arranged to be interchangeable with other pairs, four sets in all being provided so that speed ratios of 1:1, 1:1.8, 1:2.7, and 1:7 were obtainable. With these interchangeable gears and with some variation in the speed of the waterwheel there is no question of being able to control the amount of alum delivered to the water.

The drawing shows the arrangement of the gears and the photograph indicates their general appearance when assembled. The hopper is the most conspicuous part of the picture and is the least satisfactory feature of the installation. The slope of the sides is not steep enough, the rapid flare being due to the lack of head room. It would be better if the hopper were deeper and smaller at the top, since occasionally the powdered alum does not run freely to the bottom.

APPLICATION OF ALUM

The waste-water of the wheel that runs the gears is discharged upwards into a central box (an inverted pyramid) where the dose of alum is delivered and immediately put into solution. This solution overflows into the large box shown and thence through a 2½-in. pipe to the raw water pipe. The discharge is into the center of a vertical 18-in. pipe and the mixing is done partly in the pipe and partly in the baffled passage outside.

The alum is lifted up to the hopper in a medium sized excavating scraper, rigged with a special bail. The scraper holds just a bagful or 200 lb., which lasts about 12 hours, in treating 3,000,000 gal. a day. A counter is fastened to the conveyor shaft and the operator is guided by a table that tells him the number of seconds required for one revolution for various turbidities and rates of flow.

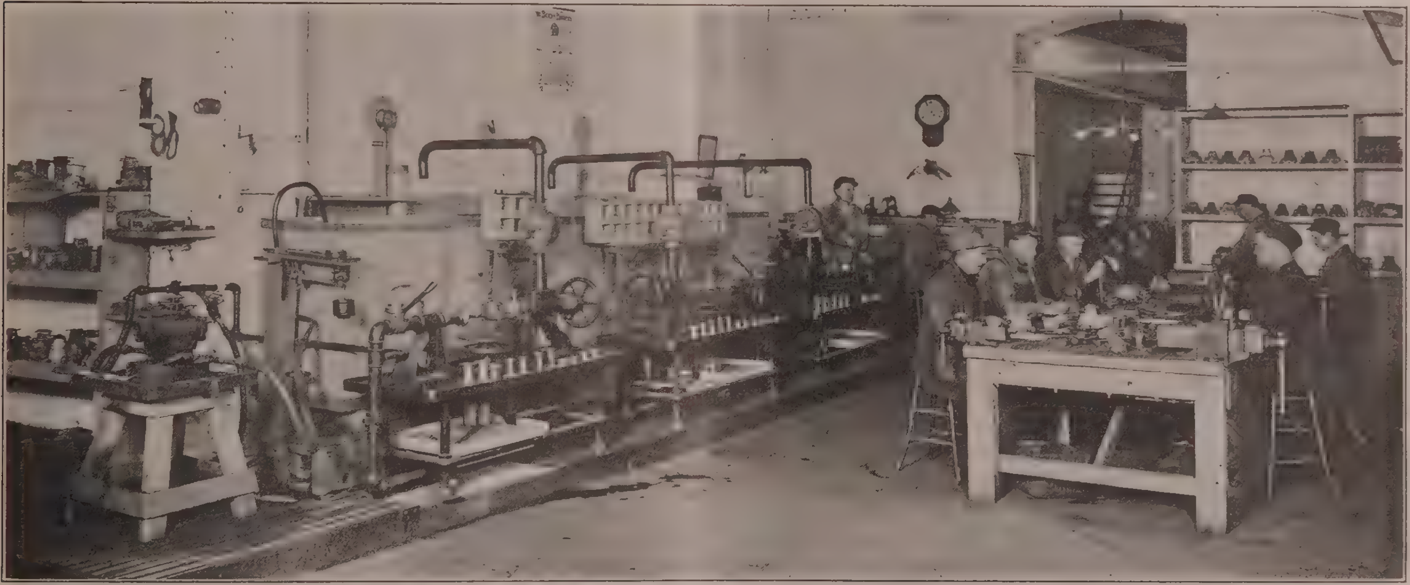
The cost of the apparatus, including boxes, piping, gears and elevator was $140, most of the installation being done by the operators in their spare time.

The idea of the apparatus was suggested to the writer partly by an article by Allen Hazen in the Engineering Record of July 19, 1913, page 71, and by a glimpse of a similar device in operation at the Watertown filter, which was installed by Hazen & Whipple.

Meter Maintenance Systematized by Waterworks Department in Milwaukee

Day Flushing Causes Sand to Deposit in Meters—Motor Truck Maintenance Costs Warrant Replacing of Horse-Drawn Service Vehicles

SAND, which entered the distribution system of the Milwaukee waterworks department previous to 1895, still causes trouble with the meters, according to the 1914 annual report of the waterworks department. After a thorough investigation about a year ago steps were taken to flush the mains in the expectation that it would greatly diminish the number of meters requiring attention on account of sand troubles. The sand is believed to have accumulated in the distribution system prior to the construction of the present long intake. The great amount of sand in the system could not be removed by one flushing, and as the flushing was done during the day hours a large number of meters were "sanded." As it is not practicable to shut off the supply while the mains are flushed, the plans of the department for the coming year are to organize a night crew and continue the flushing at a time when nearly all services are inactive. With the distribution system rid of all sand the present low turbidity of the water supply should make sand troubles a thing of the past. When this is accomplished it will effect a great saving, as the department cannot consistently make a charge in case the meter requires nothing further than the removal of sand.



ONE MAN TENDS THREE METER TESTERS IN THE REPAIR AND TESTING SHOP OF THE MILWAUKEE WATERWORKS DEPARTMENT

COST AND RECORD OF AUTO TRUCKS AND LIGHT CARS IN MILWAUKEE

Car No.	Miles made	Gal. gas.	Miles per gal.	Cost of gas., oil and grease	Repairs and miscel.	Depreciation	Tires	Cost per day incl. depreciation	Total cost per mile, incl. depreciation
2	5,622	630	9	$93.72	$385.25	$207.99	$133.76	$2.73	$0.146
4	6,033	614	9.5	89.32	33.89	223.18	28.54	1.24	.062
6	6,271	458	14	66.95	64.24	75.22	85.92	.97	.046
8	6,719	409	·16.5	58.41	25.52	80.61	113.11	.92	.047
Total	24,645	2,111	*12	$308.40	$508.90	$587.00	$361.33	*$1.47	*$0.073

*Average.

60,958 METERS IN SERVICE

During the year 2285 new meters were added to the service and 560 taken out of service, making a total of 60,958 now in service. Of these 8976 were taken off to be examined and repaired, 7131 were examined and repaired on the premises and 268 of the larger meters were retested on the premises. A total of 16,375 meters, or 26½ per cent of the meters in service, were looked after. Large as this number may appear, only 3016, or 5 per cent, required new repair parts. The cost of these repair parts, as well as the time spent in repairing, was charged to the consumers and paid by them. The expense of the remainder, or 13,359 meters, was borne by the department.

MOTOR TRUCKS REPLACE TEAMS

The meter department now has four auto trucks in use, which replace the horses and wagons formerly used. During 1915 two cars will be added. The results obtained from auto trucks have proved satisfactory and far superior to the horse-drawn vehicles. A total of 24,645 miles was covered by the four trucks, at an average cost of 97 cents each per working day, exclusive of depreciation.

One of the new cars to be bought this year is intended to be used by one man for making minor repairs to meters on premises. At present three men are required for this work. The other new car is intended to be used for emergency calls from consumers, such as frozen or burst meters, stoppage or bad leaks. These calls require prompt attention, so as not to cause property loss or unnecessary inconvenience to the consumers.

In the accompanying table cars 2 and 4

are ¾-ton Kissel trucks and the other two are Fords. No. 2 was overhauled in February, 1914, at an expense of $303.04, having been put in service in 1912. No. 4 was bought the next year and the Fords were purchased early in 1914. Depreciation was estimated on the basis of a mileage of 40,000, the trucks at 3.7 cents per mile and the Fords at 1.2 cents.

Large Meters Tested Often

In order to obtain full registration on the meters supplying the 100 consumers paying one-half of the entire meter revenue, a special card record is kept so that the inspectors at all times can see the condition of them. All meters of 3-in. and over are so equipped that they can be retested without much time or expense on the premises, without disconnecting them, by means of a proved or test meter. By closely watching the registration and prior tests it is an easy matter to decide which meters are overtaxed and in need of retesting and adjustments.

During the year 1914, 268 of these large meters were retested. The average loss by under-registration per meter was 0.38 per cent; in 1911 the loss was 9 per cent.

Meter Pit Tests

Ten meters were set in concrete or clay sewer pipe pits between the curb and the sidewalk in locations as different as possible. The tests extend over two winters. During this time weather conditions have been about as severe as ordinarily encountered and not in a single instance has any difficulty been experienced with meters, neither as regards accessibility nor frost. Sufficient tests have been made to warrant such a setting for meters that cannot conveniently be placed on the inside of buildings. Several slight improvements in regard to such installations have manifested themselves during the test so far conducted.

1. A testing valve should be provided on the outlet side of the meter so that the meter reader can readily determine whether or not the meter is registering. The present valve, for shutting off the supply to the premises when the meter is to be removed, can be constructed to serve this additional purpose.

2. Under certain conditions the small iron cover on these pits becomes wet and dirty on the outside, due to external conditions, and wet and rusty on the inner side due to condensation of moisture. In the present form these covers must be handled to be removed and replaced, and it is practically impossible for meter readers to keep field notes and themselves in a presentable condition. The locking device should be so arranged that the key, when releasing the locking bolt, will act as a handle whereby the cover can be removed and replaced without touching the cover proper.

3. These pits should be constructed so that the top of the small iron cover will be at least 1 in. above grade to prevent them from being covered with water and slush and freezing down. If set at or a trifle below grade surface water finds its way over the cover, carrying a deposit which in cold weather freezes down the cover. It is almost impossible to remove covers during the winter time where they are at or below grade.

Sweating Dial Glasses

A great deal of difficulty is experienced by field men during certain periods of the year due to sweating dial glasses. Whenever the temperature of the air on the outside of the dial glass is lower than the temperature of the water in the meter the glass fogs and later condenses into drops, obscuring the hands on the dial or at least distorting them to such an extent that it is impossible to obtain a correct reading of the meter. It is necessary to heat the glass to remove the condensation or break the glass to get a reading. It has been suggested that small holes be drilled in opposite sides of the register box between the glass and dial to allow the circulation of air. While this method will remedy the difficulty in a measure it is a long way from entirely removing it.

All meters in Milwaukee are required to be set in a wooden box for protection. The time-honored diamond-shaped opening in the top through which readings were taken has been done away with, and there now exists no good reason why the glass over the dial face should not be omitted. It has afforded very little protection to the register, as the experience of the department has shown. Any falling object would break the glass and destroy the dial face. If the dial face was not mutilated by the breaking glass, the small particles of glass would wedge under the hands, twist them off and entirely disturb the registration. It was suggested that a test be made with an especially constructed dial cap or register box cover that fits over the top of the register box and so adjusted as to automatically close. This would offer a great deal more protection than a glass, afford the meter reader an opportunity to clean the dial if dirty and avoid the great difficulty with sweating glasses. Further, quite a saving of meter repairers' time would be effected, as there would be no need to send men to clean the dials or repair broken glasses.

H. P. Bohmann is superintendent of the Milwaukee waterworks.

End Pressure Broke 60-Inch Cast-Iron Water Main in Cincinnati

John W. Alvord, Consulting Engineer, Makes Public Findings of Investigation of Vital Importance to All Waterworks Officials

LONGITUDINAL compression induced by end contact split a section of a 60-in. water main in Cincinnati on Dec. 6, 1913, drowning three men in a nearby sewer trench and depriving the city of its full water supply for four days. Lawsuits, involving large damages in behalf of the three men, were instituted at once and on that account no very satisfactory explanations were given out by anybody. As the suits have now been settled Mr. Stetson, engineer of the Pennsylvania Railroad Company, and John O'Gara, president of the Marquette Construction Company, asked John W. Alvord, who examined the break in the interests of the contractor, to make public the results of the investigation.

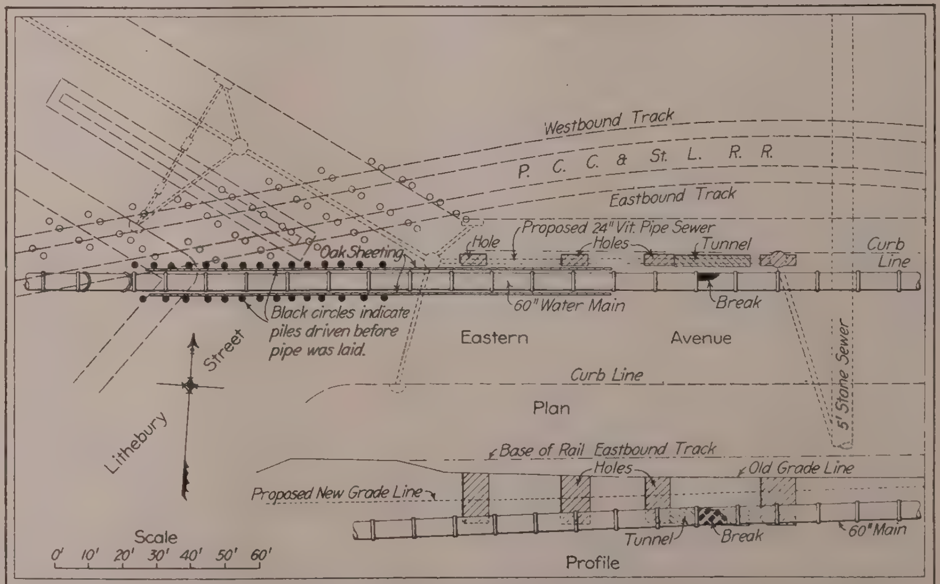
Conclusions

It is believed that the the cause of the end stress may have been lack of end clearance in laying, or it may have resulted from closure since laying by lateral pressure from the north or bluff side of the pipe.

The longitudinal pressure was possibly increased by the fact that all secondary influences, such as jar from trains, pile-driving and landslips, occurred on the northerly side of the pipe, which presented a slight convex curve in that direction all along the pipe line on both sides of the break.

The particular influence which increased the longitudinal pressure to rupture point can hardly be identified. It probably was not a large force, taken by itself. Any increase of land pressure or accumulated jars would have been sufficient in the strained condition of the pipe line to have compelled the final rupture.

It is not conceivable, from an engineering point of view, that the sewer trench being excavated alongside could have been even the completing cause of the rupture. The trench was fully braced and did not reduce the supporting lateral pressure of the earth against the main. Its depth and position were not such as to cause even conservative



LOCATION OF BREAK IN 60-INCH CAST-IRON WATER MAIN NEAR ROCKWOOD CROSSING IN CINCINNATI

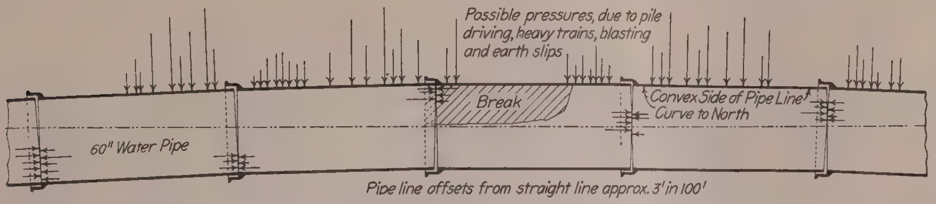

Possible pressures, due to pile driving, heavy trains, blasting and earth slips
Break
Convex Side of Pipe Line Curve to North
60" Water Pipe
Pipe line offsets from straight line approx. 3' in 100'

DIAGRAM ILLUSTRATING HOW LONGITUDINAL PRESSURE CAUSED JOINT CONTACT AND LATERAL THRUST OR JAR ON CONVEX SIDE OF CURVE

criticism. There was no hammering of sheeting going on at the time of the rupture. The more plausible explanation is that the jar of a passing train or an increase of lateral thrust from the sliding bluff added the final few pounds of stress which, in connection with the strain already present, caused the final break, and the fact that the trench for the drain was open at that time can only be regarded as an unfortunate coincidence.

If the theory above outlined is correct, it is probable that some danger still exists of another break in this vicinity unless the sleeve and short length used in the repair were so laid as to provide for play in the length of the pipe. The protecting effects of such play would not, however, extend very far away from its immediate vicinity.

SURROUNDINGS

The accident occurred at a point 140 ft. east of the center of a new subway which was being built to carry Eastern Avenue under the Pennsylvania Lines. Piles had been driven to support the tracks during excavation. Over fifty piles were in place, the nearest to the main being 5 to 10 ft. away, and the nearest to the break being about 50 ft. away. The excavation was not yet made.

About 200 ft. west of the break the tracks crossed over the pipe and were supported by piers and I-beams at that point. Examination of the plat shows that the pipe line was not straight, but from west to east had a slight deflection, beginning at or near Lithebury Street, amounting to an offset of about 3 ft. in 100 ft. for 400 or 500 ft. The convex side of this curve was presented to the north or railway and bluff side of Eastern Avenue.

Piling and sheeting driven alongside the pipe near the break at the time it was laid in 1906 and 1907 were found in good preservation and without signs of movement when uncovered by the subway excavation in July and August, 1914, seven months after the accident.

The trench for a 24-in. drain for relieving the nearby subway of rain water was being excavated along the north side of the 60-in. main. The center line of the drain was 3 ft. 9 in. from the side of the water main. Its bottom was level with the bottom of the water main at a point 12 ft. west of the break, and dipped down so as to pass under the main at a point about 15 ft. east of the break. The excavation was in fairly stiff shaley clay, and was accomplished by excavating holes 22 ft. apart, with tunnels between, as shown on the diagram. The three men who were drowned were working in the holes east of the break at the time of the accident. The pits and the tunnel were sheeted and braced in the usual manner, and the tunnel was being driven by experienced men. Little or no water was encountered and the work was not thought "difficult."

Heavy trains were continually passing on the main line tracks of the Pennsylvania Railroad, and interurban service on the double track trolley line in Eastern Avenue. The ground was partly frozen at the time of the accident.

SLIPS AND SLIDES

Test pits made by the railroad company, 25 ft. north of the break, showed that all of this ground, down to a level below the bottom of the pipe in this vicinity, had been overturned and displaced by slips and slides. The bluff to the north of the Pennsylvania Lines and Eastern Avenue rises steeply to a height of 150 ft. or more, and is composed of layers of shale, clay and rock. It is full of springs and the surface is now and has been for many years past slipping directly toward Eastern Avenue in an intermittent manner, causing on the side of the bluff the wreck of several houses and extensive street repairs to the road running up the bluff north of Eastern Avenue. The soil in the excavations near by shows evidence of earth overturn and sliding mixing. Visible evidence of recent displacement was not apparent to Mr. Alvord, however, in Eastern Avenue, either to the trolley lines, the curbs or the pavement, or the 60-in. main.

Other test pits show that all the ground from 12 to 20 ft. below the surface in the locality of the break had at some time or other been subject to slips, and the line between the sliding ground and the undisturbed soil below is usually distinct, the horizontal shale fragments being overturned.

VERTICAL BEND PREVENTS MOVEMENT

In the west abutment of Eastern Avenue crossing there is a vertical rise to the 60-in. main which has been embedded in concrete. This vertical bend and concrete anchor evidently holds the pipe at this point from either marked longitudinal or lateral movement, while to the east of this point in the direction of the rupture there is more opportunity for the lateral and compressive thrust to be brought into play. It is believed that this fact has an important bearing on the location and cause of the accident.

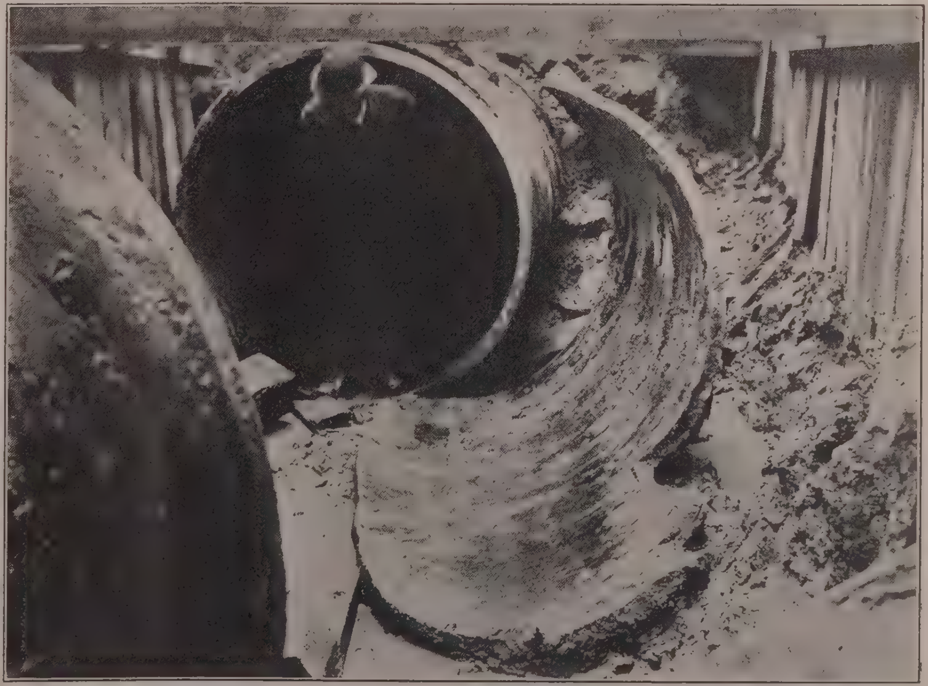
The break occurred at a point about 150 ft. from the vertical bend in the north side of the 60-in. water pipe, the side against the bluff and the Pennsylvania Railroad tracks, a piece approximately 8 ft. long, and one-half the pipe at the bell being blown outward.

CONDITION OF PIPE

As to alignment the condition of the pipe was as good apparently as when laid. At the break the shell was within 1/16 in. of the nominal thickness of 1⅝ in. and considered excellent. It was made at the Addystone plant of the U. S. Cast Iron Pipe Company. No trace of old breaks, blowholes were noted. The iron was clean, gray and granular. There was no evidence of old cracks that Mr. Alvord could observe, although others thought there was a slight crack at the bell, apparently an old crack. The pressure on the main at this point was ordinarily 80 to 90 lb., and this pressure could not be materially exceeded as the main had direct connection with the Eden Park reservoir.

Tests were made of pieces of the broken length under the direction of John W. Hill, consulting engineer, of Cincinnati. They show no cause for any criticism of the material of which the pipe was made.

Mr. Hill, after inspecting the pipe for 100 ft. east of the break, states that the ends of all spigots at some point in the circumference had been butted up, metal to metal, against the shoulder of the bell and under this condition of pipe laying motion of the pipe in any direction might produce stresses in the spigot or bell, beyond those that the pipe could resist and of a kind not anticipated in the design of the pipe.



PIECE OF CAST-IRON PIPE BROKEN FROM 60-INCH MAIN BY END PRESSURE

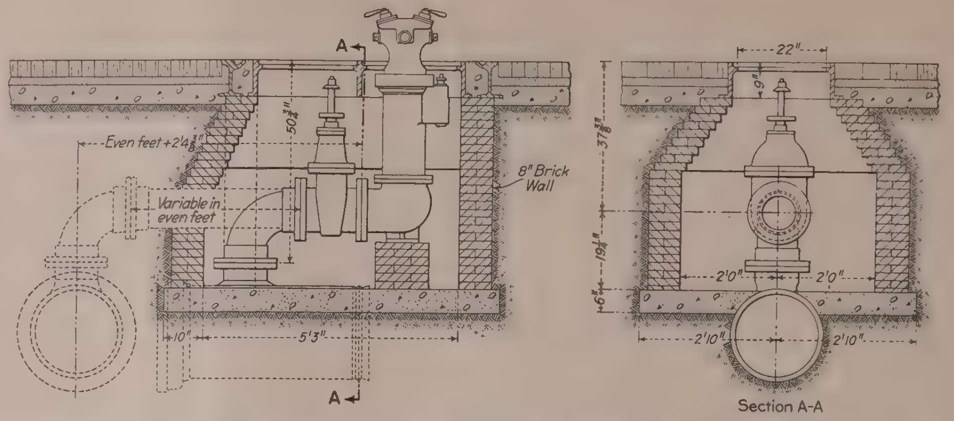
Cincinnati Builds High-Pressure Fire Service System

Pumping Station Will Use Filtered Supply Instead of Raw Water from Ohio River—20-Inch Main Girdles District

By J. A. HILLER
General Superintendent, Cincinnati Waterworks

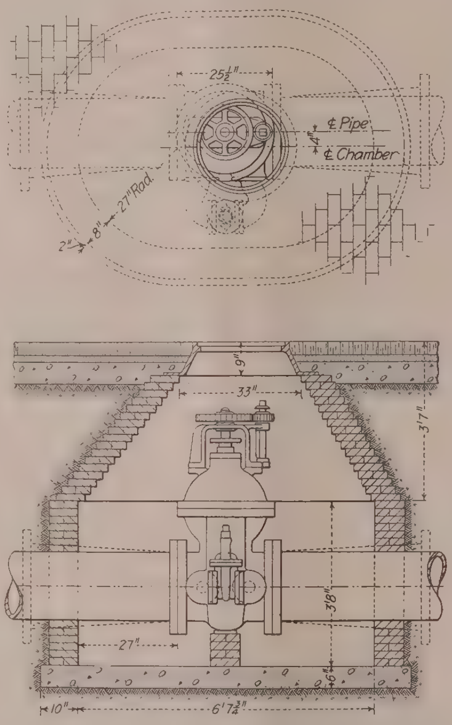
WHETHER to use raw Ohio River water or the city's filtered supply was the question to be decided when studies were begun last year for Cincinnati's pumping station and high-pressure fire system, for which a bond issue of $400,000 had been approved for the first portion of the work. A 70-ft. variation in the level of the river was a prohibitive factor in the scheme for using raw water. During floods a river pumping station could have been reached only by boats and would have been called upon to operate against a head 60 ft. greater than would be the case for a plant using the filtered supply. These considerations led to the adoption of the filtered city water as the source of supply for the fire service system. The plan approved provides for a pumping station at Eighth Street and Eggleston Avenue. The first district in which mains will be laid extends north and south from Third to Eighth Streets and east and west from Central to Eggleston Avenues. The congested or high value district lies at an elevation of 120 ft. above low water in the Ohio River.

The pumping station site is adjacent to a 36, a 40, and a 48-in. main, each independent of the other. The first is the outlet of the Eden Park reservoirs where there is a reserve supply of 100,000,000 gal., the latter two being the direct extensions of the pumping line from the main pumping station, where there is an available pumping capacity of 75,000,000 gal. per day. Suction mains will be run from each of these mains and water will be delivered to the pumps at a pressure of about 55 lb. With the rejected raw water pumping plan there would have been a suction lift. Another advantage is that the high pressure mains will be filled at all times, thus avoiding the use of automatic air cocks. Then too the pumps will be required to raise the pressure only from 55 lb. to the amount required at any particular fire. The interest charges on the increased cost of a pumping station on the river front would have been greater than the cost of filtration and pumping of the city supply used for fire protection.



WHEREVER POSSIBLE HYDRANTS, ALL WITH PORTABLE HEADS, ARE PLACED BETWEEN THE STREET CAR TRACKS

There are two reasons for this location: In winter snow is first removed from tracks, making hydrants accessible; hydrants in street are less liable to be damaged by falling buildings than if at curb



ALL VALVES ARE PLACED IN BRICK CHAMBERS

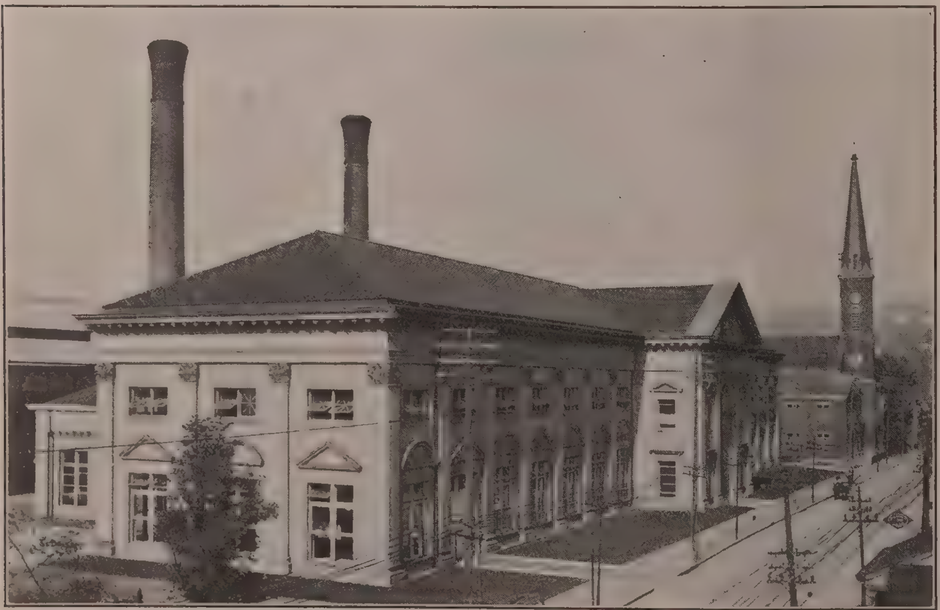
Twenty-Inch Main Around District

The system of mains laid out is such that the district now under consideration is surrounded with a 20-in. main. The district is then subdivided into four parts by the laying of two 16-in. mains each way through the center. All other mains are 12 in. in diameter. Four valves are placed at every cross intersection and three at every tee intersection, so that any intersection or any single block may be shut off without interfering with any other part of the system. All valves are placed in brick chambers, with cast-iron curbs and covers, marked "H.P.F.S. Valve." All pipe are cast iron with double grooves in hubs and on spigots; special castings are of semi-steel with flanged ends, the flanges being machined for tongue-and-groove joints. Valves have similar flanged connections. All pipe, specials and valves are tested to 600 lb. before shipment and all completed mains are tested to 400 lb. before trenches are back-filled.

Hydrants Have Portable Heads

All fire hydrants are of the flush type with portable heads, the same as those used in the Baltimore high-pressure system. (See Engineering Record, Oct. 19, 1912, page 442.) The branches for hydrants are 8 in. in diameter and each has an independent valve, so that hydrants can be repaired without shutting off the mains. Wherever possible the hydrants are placed between the street car tracks. This is done for two reasons: The traction company is always the first to remove snow from the streets, and by having the hydrants in the street, rather than on sidewalks, there is less danger of injury in the case of falling walls. The hydrants with the controlling valves are placed in brick chambers with curb and covers, the covers are marked to distinguish the hydrant from the valve.

The 20-in. main to be laid in Broadway, from Eighth to Hunt Streets, and in Reading Road, from Broadway to Elsinore Avenue, connects with the high service domestic supply. By opening a valve placed near Elsinore Avenue, the high service supply can be admitted to the fire system in case of any shutdown at the pumping station. This water can be delivered to the hydrants at a pressure of 170 lb.



THE MAIN PUMPING STATION FOR CINCINNATI'S DOMESTIC SUPPLY

New Sedimentation Basin Will Halve Costs of Sand Cleaning at Philadelphia Filters

Turbidity Load on Torresdale Plant Will Be Greatly Relieved, Algae Growths Prevented, and Output of Filtered Water Considerably Increased

By FRANCIS D. WEST
Chemist in Charge, Torresdale Filters, Philadelphia

SIX important improvements in the operation of the Torresdale filtration plant at Philadelphia, which comprises pre-filters, slow-sand filters and disinfecting apparatus, will be effected by the new 100,000,000-gal. sedimentation basin which was placed under contract recently:

1. The water will be safe, from the sanitary standpoint, every minute of the year without the necessity of sterilization.
2. Clear water will be produced at all times; at present the plant yields a clear effluent only during forty-eight or forty-nine weeks of the year.
3. The cost of cleaning the filters will be reduced. High turbidity of the raw applied to the filters means deep penetration of material into the sand layer, higher cost of cleaning and the necessity for cleaning down to the gravel, about 28 to 34 in., at least every other year.
4. Algae growths on the final or slow sand filters will be prevented. The runs of the filters are reduced by algae washed down by heavy rains following dry weather.
5. The output of the plant will be increased.
6. Color will be removed and a sparkling effluent produced.

The number of positive tests for B. coli in the filtered water during 1914 showed 0.5 per cent for 1-cu. cm. and 8 per cent for 10-cu. cm. samples. That this result was due to disinfection is shown by the figures for filtered water prior to sterilization—23 per cent of the 1-cu. cm. B. coli tests and 61 per cent of the 10-cu. cm. tests were positive.

There is no question but that the use of alum will reduce the number of bacteria applied to the pre-filters by 50 per cent; that the effluent of the slow-sand filters will be greatly improved; that the amount of disinfectant needed will be reduced; and that the treated water will be safe. Washington, D. C., using coagulation before filtration with slow-sand filters, employs no disinfectant.

TABLE 1—AVERAGE TURBIDITY OF DELAWARE RIVER AT TORRESDALE

Year	Turbidity	Year	Turbidity
1907 (6 mo.)	32	1911	16
1908	39	1912	37
1909	37	1913	29
1910	25	1914	20

TABLE 2—MAXIMUM TURBIDITY, JULY, 1907, TO MARCH, 1915

Year	Delaware River	Effluent pre-filters	Filt. water basin
1907	190	...	10
1908	720	...	18
1909	350	*260	24
1910	260	130	8
1911	97	50	3
1912	1050	610	51
1913	360	160	2
1914	400	300	14
1915	660	510	35

*Pre-filters started 1909.

TABLE 3—TURBIDITIES OF 50 PARTS PER MILLION OR MORE, BY YEARS

Year	50-99	100 or over
1907*	11	9
1908	23	16
1909	16	19
1910	11	9
1911	10	0
1912	11	19
1913	23	18
1914	8	14
1915§	10	14
Total, 7 years 9 months	123	118

*Last six months. §First three months.

TURBIDITY AND THE SLOW-SAND FILTER

The writer was greatly interested in the paper by George A. Johnson on "Present-Day Practice in Water Purification" and especially in the discussion which followed at the Philadelphia convention of the American Waterworks Association last year. The general trend of sentiment appeared to be that slow-sand filters were only suited for waters containing very little suspended matter. Fifty parts turbidity appears to be the limit that slow-sand filters can handle successfully without preliminary treatment. Robert Spurr Weston, in his discussion, limited the amount to 30 parts. The writer is in entire accord with his views. Washington uses coagulant when the turbidity reaches 30. It is very probable that after a time this will be the figure at Torresdale, although at the start 50 will be the mark.

Taking Mr. Weston's figure of 30, there were four years in eight when the average turbidity of the Delaware River was above and only twice, in 1911 and 1914, was the average much below.

Referring to Table 2 an average turbidity of 1050 was reached in 1912, although individual tests were over 1200 (8 tests are made daily and averaged).

Table 3 shows the number of times, by years, when the Delaware River has had a turbidity of 50 or over—123 times between 50 and 99 and 118 times 100 or over.

Table 4 shows the number of times by months that 50 has been reached. It will be seen that during January, February and March the turbidity has exceeded 50 parts 150 times, or 60 per cent of the total number.

The filtered water always is clear from April to October inclusive. It is during the spring and sometimes late in the fall when difficulty is experienced in operating the plant.

TABLE 4—TURBIDITIES OF 50 PARTS PER MILLION OR MORE BY MONTHS

Month	1907	1908	1909	1910	1911	1912	1913	1914	1915	Total
Jan.	0	7	5	5	3	0	4	8	12	44
Feb.	0	11	10	5	2	8	1	6	11	54
March	0	9	2	4	2	14	13	7	1	52
April	0	0	0	3	0	3	4	0	0	10
May	0	6	1	0	0	0	1	0	0	8
June	0	0	0	1	1	0	0	0	0	2
July	1	0	0	0	0	2	2	0	0	5
Aug.	0	0	0	0	1	0	0	0	0	1
Sept.	6	1	0	0	0	0	0	0	0	7
Oct.	1	0	0	0	0	2	6	0	0	9
Nov.	7	2	1	2	1	2	5	0	0	20
Dec.	5	3	16	0	0	1	4	0	0	29
Total	20	39	35	20	10	32	40	21	24	241

TABLE 5—TURBIDITY OF 5 OR MORE, TORRESDALE FILTERED WATER BASIN

Month	1907	1908	1909	1910	1911	1912	1913	1914	1915	Total
Jan.	0	6	6	2	0	0	0	5	10	29
Feb.	0	14	10	1	0	8	0	4	4	41
March	0	23	0	0	0	10	0	0	0	33
April	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0	0	0
Aug.	0	0	0	0	0	0	0	0	0	0
Sept.	3	0	0	0	0	0	0	0	0	3
Oct.	1	0	0	0	0	0	0	0	0	1
Nov.	0	0	0	0	0	0	0	0	0	0
Dec.	15	2	9	0	0	0	0	0	0	26
Total	19	45	25	3	0	18	0	9	14	133

Table 5 shows the number of times when the filtered water had a turbidity of 5 or over. Omitting 1913, when alum was used experimentally and applied to the water before it was pumped to the pre-filters, it will be seen that a turbidity of 100 in the river means a turbidity of 5 or over in the filtered water basin.

TABLE 6—COMPARISON BETWEEN TURBIDITY IN TORRESDALE BASIN AND RIVER

Year	Delaware River, 100 or over	Filtered water basin, 5 or over
1907 (6 mos.)	9	19
1908	16	45
1909	19	25
1910	9	3
1911	0	0
1912	19	18
1913	18	0
1914	14	9
1915 (3 mos.)	14	14
Totals	118	133

A turbidity of 5 will be noticed by the ordinary consumer if he is accustomed to clear water and in the writer's mind 5 is the limiting figure for filtered water. The Torresdale filtered water basin had a turbidity of 24 in 1909, 51 in 1912, and 35 in 1915. Water of such a nature will be refused by the consumer and although it may be safe it reflects on the filter plant and bottled water firms continue to do business in Philadelphia.

COST OF FILTRATION

The cost per million gallons filtered (plant management, not including pumping) follows: 1907, $3.75; 1908, $2.80; 1909, $1.70 (pre-filters started); 1910, $1.82; 1911, $1.66; 1912, $1.91; 1913, $1.92; 1914, $2.23.

The high cost for 1914 was due to low efficiency of the pre-filters, the year's average being but 53 per cent, to the deep cleaning in December necessitated by microscopic penetration, and deep cleaning in the spring due to turbidity. High turbidity means deep cleaning and omitting microscopic growth the less turbidity applied to the filters the less the cost of cleaning. It is estimated that the cost of cleaning in the spring will be reduced fully 50 per cent.

ALGAE

The question of algae has been given scant consideration in the discussion of the relative merits of slow-sand and mechanical filters. It has proved to be a very important element at Torresdale. The Delaware River contains considerable organic matter, in summer has numerous micro-organisms, and with very low turbidities the filters go out of service very rapidly. This point was discussed in a report to the chief engineer of the department in December, 1914, and may bear repeating.

"Micro-organisms are composed of or surrounded by a jelly-like substance which clings to the sand and forms hard, compact layers on the filters. This was especially noticeable at Torresdale in 1908 when the Brooklyn method was used. A hard, pasty mass was formed 6 in. below the surface, so hard that it could be picked up by hand in cakes 8 in. in diameter.

"The autumn of 1914 was especially dry, the turbidity for August, September and October being 8, 7 and 9, compared with 21, 19 and 38 for 1913. Very little organic growth was washed down by rains and after a heavy rain on Dec. 6 the tests for organisms of Dec. 8, 15 and 18 showed 966, 1194 and 1086 organisms per cubic centimeter. The average for December, 1913, was 173. Although the turbidity for December, 1914, averaged but 22 these organisms penetrated the filters and choked the entire plant."

COLOR

The color of the Delaware River, while not high, is very noticeable and the slow-sand filters remove only about 30 per cent. It is expected that the use of alum will reduce the color to 5 or less.

FEATURES OF NEW BASIN

The new sedimentation basin at the Torresdale filter plant is located upstream from the present intake. The new intake is about 2400 ft. north, nearly a half mile further away from the sewage of the city. The intake house is close to the shore with a channel extending to the Port Warden's Line. A bulkhead protects the intake from ice. The channel is 100 ft. wide and coarse floating material, logs, etc., will be prevented from entering by a log and chain boom.

The walls of the basin are made of 10 x 10-in. yellow pine, bolted together. The construction of the crib will be made to suit conditions. The crib will support riprap having slopes of 1 on 2 and 1 on 3. The fill between the cribs will be made from dredgings.

The basin will have an area of 2000 x 500 ft. and a total depth of 23 ft. The depth of water under ordinary circumstances when full will be 15 ft., giving a normal capacity of 100,000,000 gal. or 12 hours' supply.

OPERATION

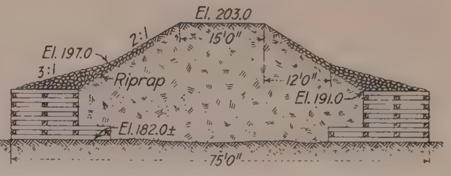
The basin will be operated on a fill-and-draw plan, the intake being open ordinarily about 16 to 18 hours out of 24. Twenty-four hinged tidal gates, 4 ft. 3 in. x 3 ft. 2 in., arranged in six sets of four each in two rows allow the water from the river to enter the basin, the amount varying with the elevation of the water. When the depth of water in the basin exceeds that in the river the gates will automatically close. At times of freshets the gates will probably be open throughout the 24 hours. A chain attached to one of the upper gates controls 4-in. gate valves which feed the chemicals into the mixing chamber. The amount of chemicals vary as the amount of water entering the basin. The tidal gates will be protected by screens.

Before passing the tidal gates the water receives treatment with alum or, if necessary, with alum and soda. The use of chemicals will be governed according to conditions as explained. The course of the water through the mixing chamber is around the first baffle through an opening 11 ft. wide, through the middle of a second baffle, under the third baffle, and through a coarse screen. It then goes through eight arches 15 ft. long and 5 ft. wide and through a set of fine screens, passing around the next baffle, reversing its flow around the fifth baffle, passing under the sixth baffle, then going the length of the chamber and entering the basin through four 48 x 72-in. sluice-gates. On leaving the mixing chamber the water traverses the length of the basin past four baffles. A 10-ft. conduit connects the outlet chamber with the old intake conduit.

The water on entering the outlet chamber passes over four hinged gates supported by floats so that only surface water is used. Screens may be placed at either end of the outlet chamber. The flow through the conduit will be measured by pitometers. After passing through the conduit the water is pumped to the pre-filters as at present.

APPLICATION OF CHEMICAL

The mixing tank is 45 x 10 ft. in plan, and may be divided into five sections by baffles. The dry chemical is stored in a chamber 71 ft. 10 in. x 20 ft. x 7 ft. 10 in. In the floor of this chamber are hatches 4 ft. square, used for dumping the dry chemical into the storage bins below.



TYPICAL SECTION OF CRIBWORK

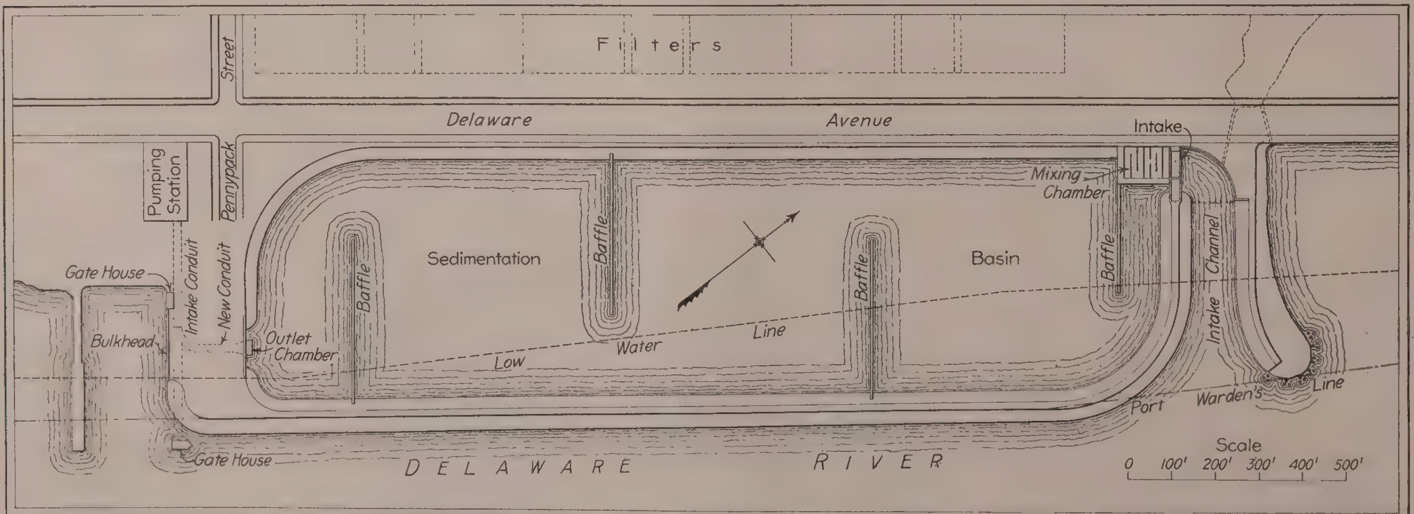
Cast-iron gates with hand levers will allow the chemicals to empty into the mixing tank. This tank is 5 ft. deep and it has a false bottom of cedar with 1 in. openings. Water enters the tank from below the false bottom through 2-in. pipes and passes up through the chemical, overflowing into a trough where five paddle wheels driven by 2-hp motors complete the circulation by forcing the water again under the false bottom. Five motors are provided, one for each section of the tank. If necessary the solution may be heated by a steam line. Clean-outs are provided for washing out the tanks.

The saturated solution passes out through a 4-in. solution pipe to the orifice tank which runs the full length of the mixing tank. Ten orifice overflow pipes regulate the amount of solution going to the operating valves. Four-inch gate-valves, opened and closed by a chain fastened to one of the upper tidal gates, feed the chemicals into the water according to the flow. The solution is fed into the mixing chamber by means of 4-in. perforated pipes.

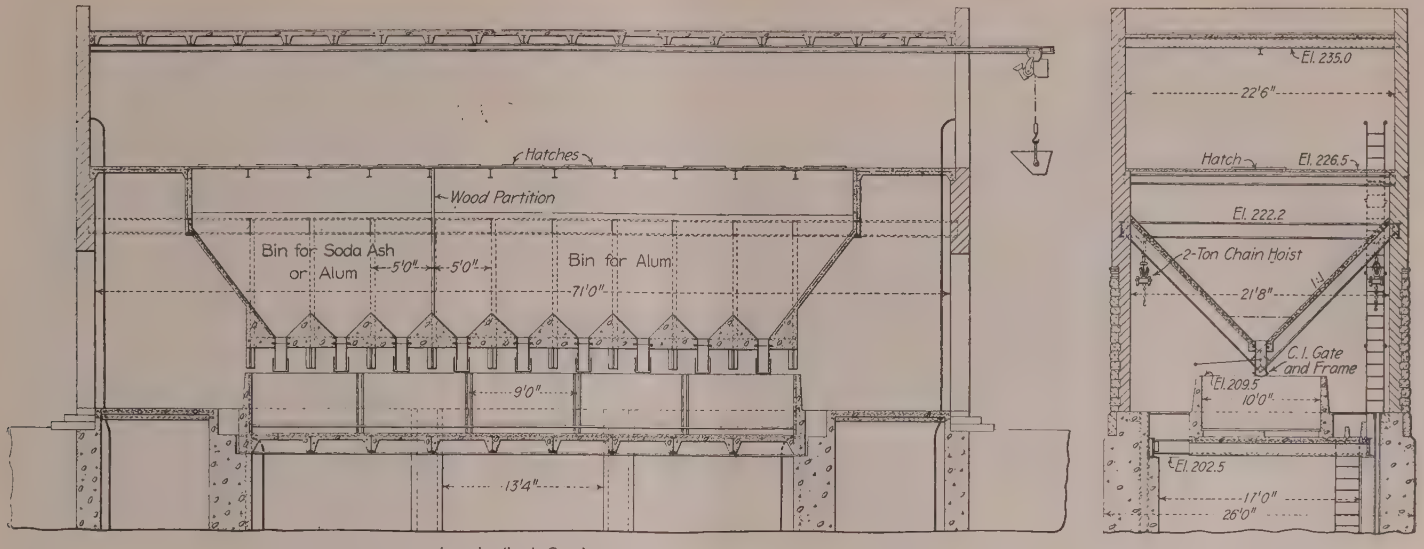
WHEN ALUM WILL BE USED

It is expected to use alum when the turbidity of the river reaches 50. It is quite possible that after a time alum will be used when the turbidity is 30. It is also a problem as to the microscopic growth, whether it will be better in summer with low turbidity to use copper sulphate in the sedimentation basin or to use alum and coagulate the growth to prevent it from reaching the filters. It is quite probable that trouble will be experienced with development of microscopic growth in the basin.

Based on the schedule in Table 7 about 2 grains per gal. with 200 turbidity and 3 grains with 800 turbidity will be required.



THE NEW PHILADELPHIA SEDIMENTATION BASIN, WITH A CAPACITY OF 100,000,000 GALLONS, WILL MEASURE 2000 X 500 FEET IN PLAN



Longitudinal Section

Cross-Section

FROM STORAGE BINS THE CHEMICAL WILL PASS THROUGH HAND-LEVER GATES INTO THE MIXING TANK

The alkalinity in February, 1915, varied from 10 to 19 and averaged 14. It is doubtful if 2 grains can be used without soda, although from experiments made in the laboratory it was found that considerable alum was absorbed by the mud. J. William Long, chemist of the Trenton filter plant, furnishes statistics showing the use of 3 grains of alum per gallon with a turbidity of 2000-2200 with the reduction in alkalinity of only 7 parts. On January 15, with a turbidity of 2000 and an alkalinity of 15 in the river, 5 grains of alum per gallon were used. The effluent had an alkalinity of 7. The use of large amounts of alum with low alkalinity at Torresdale, without soda, would not be advisable as the alum might not all be precipitated in the basin and if it should precipitate on the final filters considerable trouble with clogging would result.

TABLE 7—ESTIMATED AMOUNT OF ALUM TO BE USED

Turbidity	Lbs. alum per mil. gal.
30	140
50	160
100	210
200	280
300	320
400	350
750	420

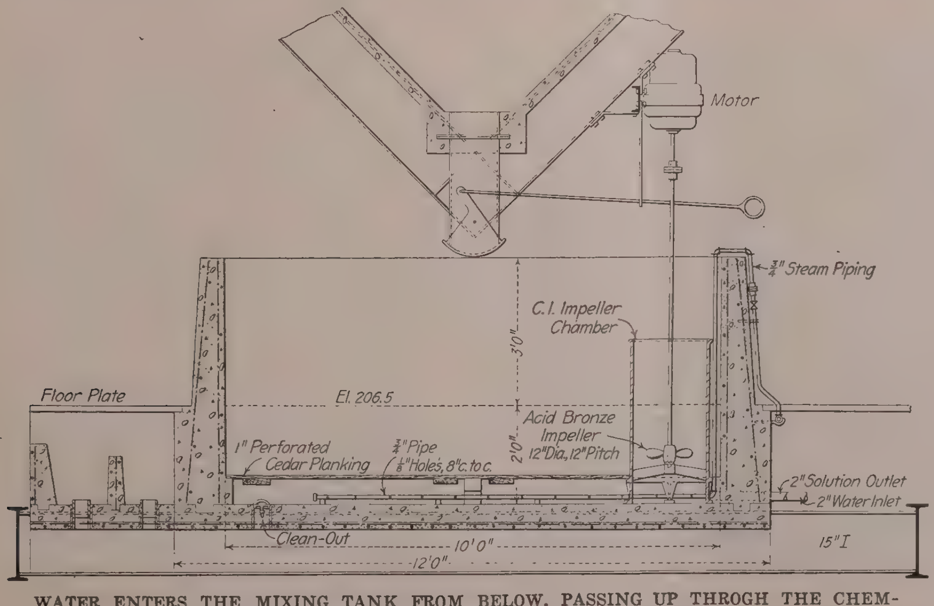
At times of high turbidity soda will probably be used. At 2 grains of alum per gallon and a plant output of 200,000,000 gal. per day, there would be needed 57,200 lb. per day or a cost for chemicals of about $500.

If it were possible to feed the pre-filters by gravity instead of by pumping when using chemicals the sedimentation basin could be divided into two parts, allowing say eight hours for plain sedimentation and four hours after coagulation. The pumps will break up the coagulated turbidity leaving the sedimentation basin; therefore at least twelve hours are needed to allow the greatest amount to settle out. Much more alum will be needed, due to absorption by the mud than would be needed if allowances were made for plain sedimentation.

RESULTS EXPECTED

With the sedimentation basin in service the days of turbid effluents from the plant will be over. It is estimated that the basin will remove 60 per cent of the turbidity; that the turbidity applied to the pre-filters will be coarser than at present; that the efficiency of the pre-filters will be increased, especially when 18 in. of sand are used instead of 12 in. as at present. The load put on the final filters will be reduced and the penetration should not be deep. The cost of cleaning should be cut nearly in half. The color of the filtered water will be low, less disinfectant will be needed and the output of the plant will be increased to 220,000,000 gal. a day.

It is quite probable that later the basin will be divided in half so one part may be cleaned out while the other is in service.



WATER ENTERS THE MIXING TANK FROM BELOW, PASSING UP THROGH THE CHEMICAL SUPPORTED BY A PERFORATED FALSE BOTTOM

Continuous Rope-Testing Machine

A CONTINUOUS rope-testing machine has been invented by Albert N. Faulkner and is used by the Chesebro-Whitman Company of New York City. It consists essentially of a series of four grooved wheels which grasp the rope in such a way that for about 8 ft. of its length it can be subjected to a known tension. The grooved wheels are made to revolve by means of an electric motor, and the tension in the rope can be regulated by means of a lever which acts on a friction brake. The sheave wheels are mounted on a sliding carriage which is connected by means of a wire cord, with a weighing device that measures the tension on the rope. It is asserted that safety would be greatly promoted in using fiber ropes if they were tested from time to time in a machine of this kind. The frequency of testing would depend upon the use to which the rope is put and the nature of the exposure that it has had. For example, when ropes are used on construction jobs there is likelihood of acid being spilled upon them, which will cause the ropes to rot or otherwise become weakened internally. Generally speaking, it is suggested that it would be advisable to test all such ropes at least once in six months, or even each time they are used if the exposure should be such as to affect their condition. A "100-ft. fall," or 400 ft. of rope, is tested by this machine in about 10 min. at the rate of operation that experience indicates to be best.

IRRIGATION WORKS, the cost of which was so high as to amount to more than $42 per acre served, were recently completed at Cougha Poort, South Africa. The construction consisted of a concrete dam across the Cougha River, 3½ miles of canal along the river bank, a steel and concrete siphon to carry the water under the river and other siphons and canals for distribution.

THE LAST SPIKE ON THE CONSTRUCTION RAILROAD FOR THE WINNIPEG AQUEDUCT WAS DRIVEN DECEMBER 17, 1914

Direct Control Over Construction Materials Is Feature of 100-Mile Winnipeg Aqueduct

Six Communities, Forming Water District, Build Construction Railroad, Supply All Cement and Deliver to Work Properly Graded Mixture of Sand and Gravel

THREE features of administrative policy combine to give to the work of building the 100-mile aqueduct from Shoal Lake to the city of Winnipeg and adjoining Canadian communities which have organized the Greater Winnipeg Water District, a unique position in the history of waterworks construction: All materials will be transported by a municipally-owned and operated standard-gage railroad, built especially by the water district to serve the contractors; all cement will be purchased by the district and supplied to the contractors; all sand and gravel will be graded by the district at a large central plant and shipped to the work in the proper proportions for direct delivery to the concrete mixers. Thus, to an unusual degree, will the district have immediate, instead of indirect, control, not only over the delivery, but also over the quality, of the principal materials which will enter into its work.

ESSENTIAL PARTS OF PROJECT

The new water supply project, which was recommended in 1913 by a board of consulting engineers, consisting of Rudolph Hering, Frederic P. Stearns and James H. Fuertes, comprises, essentially, a low diversion dam at Indian Bay, an arm of Shoal Lake; 85.036 miles of horseshoe-shaped concrete aqueduct, the largest section of which is 10 ft. 9 in. wide and 9 ft. high inside; about 10 miles of 5-ft. steel pipe; 900 lin. ft. of tunnel under the Red River, and 12,000 lin. ft. of 4-ft. cast-iron pipe leading to the city reservoirs. The conduit is designed for a carrying capacity of 102,000,000 gal. in 24 hours, sufficient, on the basis assumed for a supply throughout the year, for 850,000 inhabitants. In 1913 the population of the Greater Winnipeg Water District was 225,000, of which 200,000 were in the city of Winnipeg. The rapid growth is shown by the fact that the 1913 population was twice that of seven years and five times that of fifteen years previous. The capacity of the aqueduct was based upon the assumption that the daily per capita consumption in some months would be as high as 120 gal.

Including the railway line, which is about 105 miles long, including sidings, and an item of 15 per cent for administration, engineering and contingencies, the estimated cost of the work is $13,045,600.

SOURCE OF SUPPLY REMOTE

Winnipeg, like a great many of the smaller communities in the vicinity, is disadvantageously located for securing near at hand a supply of soft water. The ground and river water near by is so hard that it is unsuitable for manufacturing and laundry purposes, and is not very satisfactory for domestic uses. The only suitable water is found in the granite country 100 miles or so to the east and northeast of Winnipeg. This condition made it necessary to construct an aqueduct of unusual length.

Winnipeg is a prairie city about 760 ft. above sea level and contains no hills on which reservoirs could be advantageously located. The country from which the new water supply is drawn is about 300 ft. higher than the general elevation of the city, and the available slope for the aqueduct, therefore, was only about 3 ft. to the mile. All this head is consumed in delivering the water into the city reservoir.

GREATER WINNIPEG WATER DISTRICT

Obviously a project involving a 100-mile aqueduct would have been too costly for any one of the smaller towns to undertake, but by combining their resources with those of Winnipeg five other communities will benefit by the new water supply from Shoal Lake. The Greater Winnipeg Water District comprises the municipalities of Winnipeg, St. Boniface, Transcona, St. Vital, Assiniboia, Fort Garry and Kildonan. The powers of the district are vested in an administrative board, consisting of the mayors and reeves of the municipalities, the mayor of Winnipeg acting as chairman. This board decides upon all broad questions of policy, while a commission of three members, two of which have already been appointed by the board, is responsible for the execution of the work in accordance with the board's direction. Matters involving decisions on technical questions are referred to the consulting engineer, James H. Fuertes of New York City, and the construction work will be directed by the chief engineer, W. G. Chace.

THE CONSTRUCTION RAILROAD

A big problem had to be solved before bids could be advertised—that of transporting materials to the work. In addition to its great length the aqueduct line traverses a swampy country which is well-nigh impassable except when the ground is frozen, and it was realized that reasonable bids for the construction of the works could not be secured until means of access to the remote parts could be provided. The district decided, therefore, to open up the territory for construction purposes by building its own railroad and operating the line with its own forces, charging the contractors for the transportation of materials according to a schedule of rates published in advance of the receipt of bids. The route, about 90 miles long, exclusive of sidings, was surveyed, built and placed in service in a single working season, a feat of no mean magnitude considering the character of the country. The line is laid with 60-lb rails, is well drained and designed for heavy and continuous traffic. It is hoped, on each contract, to maintain a rate of progress sufficient to complete the aqueduct by the fall of 1918, and it was of first importance that no delays in the delivery of materials should be caused by road-bed defects.

The terminus of the line is at Deacon, south and west of Transcona, where the Grand Trunk Pacific shops are located. A station and a storehouse for cement and other freight has been erected at Deacon. Cars of supplies, received from foreign roads, are delivered on the transfer tracks at Paddington, near Winnipeg, and picked up by the district's train crews and unloaded at Deacon or hauled to the work. The road is a single-track line with about ten permanent sidings and spurs, and arrangements have been made to cut the track and put in switches, if necessary, at points where contractors may best be served.

The contractors are arranging their plants on a plan calling for movable wooden platforms to lie lengthwise of the main track and span the railroad ditch. These platforms, upon which the sand and gravel will be dumped direct from the cars, are in units that can be picked up and moved ahead successively as construction progresses. At each camp the contractors will provide storage for cement. At the eastern terminal of the line, at Indian Bay, are yards and storage tracks. The railroad follows the aqueduct line closely for almost its entire length.

CEMENT SUPPLIED TO CONTRACTOR

The district's policy of supplying cement to the contractor, instead of allowing him to purchase this material, was adopted primarily in the interests of sound construction. The cement is delivered to the contractor at its cost to the district. Each contractor is charged for all cement supplied to him and is credited for the actual amount that goes into the work, as reported

THE CONCRETE AQUEDUCT SECTION HAS A WIDTH OF 10 FT. 9 IN. AND A HEIGHT OF 9 FT., INSIDE

by the district's inspectors. In order to avoid disputes as to the quality of cement in case of defective work the contractor is constituted an inspector and is given all powers pertaining thereto. The cement will be inspected at the bins of the plant where it is manufactured. As soon as they are filled the bins will be sealed and the cement will be released only by the district's inspectors. It will then be shipped in sealed cars to the work or to the storehouse at Deacon. Accurate records of all cement leaving the mill will be kept, and no cement will be released until the tests have shown that it fulfills the requirements of the specifications. Several of the contractors have joined in employing an inspection bureau to check the district's tests.

Samples to be tested are collected automatically at a rate of 1 oz. per minute as the cement enters the bins at the mill. These samples will be divided among the inspectors for the district and for the contractors.

GRADING OF SAND AND GRAVEL

Except for a few miles at its western end the aqueduct is of concrete for its entire length. Great stress was laid upon the requirement that materials and methods be such as to produce uniform, watertight work. This result depends, to a large extent, upon the use of sand and gravel of suitable quality and proper grading. This responsibility the district also has assumed, instead of leaving it to the contractors, and will supply all of the sand and gravel used throughout the work in properly graded mixtures made up at a large central screening plant at the district's gravel pit at about mile 30. Local conditions made this precaution necessary for the sand and gravel obtainable in the vicinity of Winnipeg varies widely in quality. It is a glacial deposit, in which the strata are not uniform, due to outwash in ancient times. The deposits are found in various locations over the whole length of the aqueduct line, and vary in depth and in their character of stratification, as to sizes of particles. Under such conditions to have given the contractors free rein in getting their own sand and gravel would have required a standard of excellence of inspection which would have been impossible of attainment and exceedingly costly, and would have resulted in the production of concrete containing too much sand or too much stone—in other words a porous concrete which it was essential to avoid. The district, therefore, decided to supply the contractor with sand and gravel mixed ready for use, and to this end secured extensive gravel deposits which were selected after thorough and careful inspection by test borings and careful mechanical analyses of samples of the strata made at the district's laboratory in Winnipeg.

The aim has been to obtain a thorough knowledge of the locations where coarse material predominates, where fine material is to be found and where material of an intermediate character exists. It will then be attempted to work with steam shovels through the different deposits in such directions and to such depths as will give a raw material necessary for a proper aggregate with as little waste as possible. With this information in hand it is expected that there will be not over 5 per cent waste in the material collected by the shovel.

CENTRAL SCREENING PLANT

The steam shovels will load into dump-cars at the gravel bins and the cars will be hauled in trains to a central screening and mixing plant, where the raw material will be discharged upon inclined screen bars which will intercept any excessively large sizes. The material passing these bars will be raised by elevators to revolving screens and separated into four sizes—fine, intermediate, course and over-size. The over-size pieces will go to a crusher and thence again to the revolving screen. The material is sufficiently clean to obviate the necessity of washing.

The screened material will drop into three bins each provided with a spout in the bottom discharging on to a separate endless belt. These three belts deliver to a third belt running at right angles to them and leading to the storage bins. The fine, intermediate and coarse material is made to discharge on the conveyor belts at predetermined rates based on analyses and inspection, so that the material as it enters the storage bin is properly graded.

Studies of samples from different pits indicate that there will probably be an excess of fine material, basing the proportionate amount of intermediate and fine upon the amount of coarse, and that if a definite mix of the three sizes were determined upon there would be a considerable waste of material. Laboratory investigations indicate, however, that by making use of some of the extremely fine sand, which would ordinarily be wasted, a very dense concrete can be produced with practically no waste. In such cases the coarser material serves simply as pudding stones. This concrete, in which the fine material has been used, has been found to flow easily and be watertight.

The district has established a laboratory for concrete tests at headquarters in Winnipeg. Large specimens for crushing are, through the courtesy of the Engineering Department, tested in the laboratory of the University of Manitoba. Here 8-in. concrete cylinders are broken by compression, using various mixtures of fine, intermediate and coarse gravel; blocks are subjected to permeability tests in the district's laboratory.

DELIVERY OF GRADED MATERIAL

From the storage bins at the central plant the properly proportioned mixture of sand and gravel will discharge into trains of air-dump cars which will be hauled to the work and dumped upon the wooden platform along the aqueduct trench, previously referred to. The contractors will take the sand and gravel from the platform, working at right angles to the track so as to prevent any segregation of material. Experience may show that segregation may occur to a small extent during transportation, or that some of the fine material will be lost through cracks in the cars. If so, arrangements to ship out extra sand, as may be necessary, will be made.

CONSTRUCTION METHODS TO BE UNIFORM

The aqueduct has been divided into five contract sections, awarded to three contractors. In order that uniform methods may be followed on each section of the work all of the contractors have arranged to secure one type of form from the Blaw Steel Construction Company, thus systematizing methods of concreting throughout the entire

LACK OF UNIFORMITY IN MATERIAL AT SAND AND GRAVEL PITS NECESSITATED A LARGE, CENTRAL GRADING PLANT job. The inside aqueduct forms will be collapsible and plans have been formulated for handling the work in such a way as to permit continuous progress both on straight portions and on curves.

A very important construction feature will be the use of straight sections of forms on curved portions of the aqueduct. The curved alignment will, in reality, be a series of tangents of 15-ft. lengths; at the gaps in the forms where these angles occur wood fillers will be used. All of the curves in the alignment have the same radius, 50 ft., and no curve will require more than three 15-ft. sections of form. On each section of each contract it is planned to make the concreting progress 90 ft. daily.

The schedule of work laid out for the year 1915 is shown in the table below.

PERSONNEL

The chairman of the administration board of the Greater Winnipeg Water District is R. D. Waugh, mayor of Winnipeg. The two commissioners are S. H. Reynolds, C.E., chairman, and James H. Ashdown, who was mayor of Winnipeg when the water question was investigated in 1907. To Thomas R. Deacon, C.E., president of the Canadian Club of Winnipeg, and former mayor of the city, is due much of the credit for making a reality of the water supply project for the district. It was under his administration that the project took definite shape, that the Greater Winnipeg Water District was organized, that the surveys were made, the railway built and the contracts for the construction of the aqueduct awarded.

CONTRACT WORK SCHEDULED FOR 1915

Contract No.	Contractor	Length in Feet
30	J. H. Tremblay Co., Ltd..........	20,600
31	Thos. Kelly & Sons..............	27,000
32	Winnipeg Aqueduct Construction Co.	32,660
33		21,020
34		10,800

W. G. Chace is chief engineer of the work and James H. Fuertes, of New York, is consulting engineer.

Active construction on all contracts will begin this month.

AVERAGE PAY OF MUNICIPAL ENGINEERS in Chicago increased during the last four years from $1802 to $1840.

America's First Large Direct-Explosion Pump Will Irrigate Texas Lands

Unit Under Construction at Del Rio Will Have Capacity of 28,000 Gallons per Minute Against 37-Foot Head

WATER for irrigating the estate of G. Bedell Moore along the Rio Grande at Del Rio, Texas, will be delivered by the first large direct-explosion pump to be used in the United States, although pumps of this type are in service in England and are proposed for Egypt. The unit is 66-in. Humphrey gas pump designed to deliver not less than 28,000 gal. per minute against a static head of 37 ft. The installation is now partially completed. The following information regarding it is from a report by Alexander Potter, of New York City, who acted as consulting engineer on the project.

TYPES OF PUMP INVESTIGATED

To perform the work of pumping two principal types of installation were considered—centrifugal pumps driven by internal combustion engines, and a Humphrey gas pump. The decision of the type to be used has been influenced to a very great extent by the kind of fuel that can be obtained at the pumping station. As the intake is located 15 miles by road from Del Rio, the nearest railroad station, the transportation of fuel is an important factor. It has been found that Eagle Pass bituminous coal can be delivered at the site for about $4 per ton and that fuel oil will cost in the neighborhood of $2 per barrel. As much of the land to be irrigated is covered with mesquite wood and will have to be cleared, the use of this mesquite wood for fuel makes a rather attractive proposition and the possibility of its use as a fuel has been investigated with satisfactory results.

Table 1 is a comparative statement of the fuel consumption of the various economical types of pumping engines investigated. It is based on the assumptions given in table 2.

In view of the low cost of fuel consumption of the Humphrey gas pump, together with the advantage of low cost of installation and maintenance, Mr. Potter studied the European installation of this type, including that at Chingford near London, and the immense Mex (Egypt) plant, which would be now under construction but for the war. As a result of these investigations in Europe and the very satisfactory test made on mesquite fuel in the Akerlund type of gas producer, a Humphrey gas pump and Akerlund gas producer were recommended.

SITE OF THE DIRECT-EXPLOSION PUMPING PLANT IN TEXAS; MEXICANS HANDLING SECTION OF PLAY PIPE

PUMPING STATION

The pumping station is located directly upon the banks of the Rio Grande. The gas pump recommended is made under Humphrey and Smyth patents and guaranteed by the Humphrey Gas Pump Company, of Syracuse, N. Y., to pump not less than 28,000 gal. per minute against a static head of 37 ft. It is believed that the pump will deliver 30,000 gal. per minute, and all structures have been designed accordingly.

TABLE 1—COMPARATIVE STATEMENT OF FUEL CONSUMPTION OF THE VARIOUS ECONOMICAL TYPES OF PUMPING ENGINES INVESTIGATED

(Capacity of plant, 67 cu. ft. per sec.; lift 37 ft.)

Type of installation	Fuel	Fuel consumption (24 hours)	Fuel cost per acre ft. (lift 37 ft.)
Humphrey gas pump	Wood.....	8.83 cords	$0.100
	Bitum. coal	4.80 tons	0.145
Centrifugal pump and Diesel engine	Fuel oil...	14.00 bbls.	0.211
Centrifugal pump and gas engine operating on producer gas........	Wood.....	11.35 cords	0.128
	Bitum. coal	6.13 tons	0.185

TABLE 2—ASSUMPTIONS GOVERNING FIGURES SHOWN IN TABLE 1

	Per cent
Thermal eff., Humphrey pump (overall pumping hp.)	20
Thermal eff., gas engine (brake hp.) 24 per cent + pump = ...	16
Thermal eff., Diesel engine (brake hp.) 32 per cent + pump = ...	21
Thermal eff., producer, lignite fuel..............	75
Thermal eff., producer, wood fuel..............	65
Mechanical efficiency of centrifugal pump.....	65

Eagle Pass bitum. coal, $4 per ton, 12,000 B.t.u. per lb.

Mesquite wood, $1.50 per cord of 2500 lb., 6000 B.t.u. per lb.

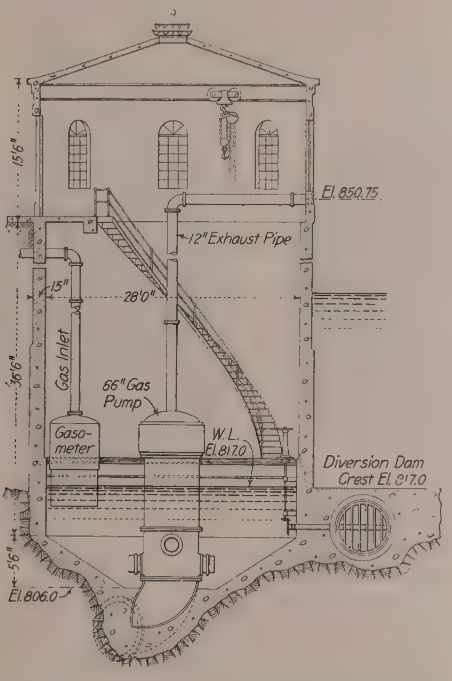
Fuel oil, $2 per bbl. of 335 lb., 18,000 B.t.u. per lb.

The thermal efficiency of the pump is guaranteed by the manufacturer to be not less than 20 per cent when using producer gas having a heat value of not less than 100 B.t.u. per cubic foot. Both the pump cylinder and the play pipe are 66 in. in diameter. The total length of the play pipe is approximately 100 ft.

Water level in the pump well is maintained at a constant elevation, irrespective of the water level in the river, by means of a hydraulically operated gate valve. This gate valve is to be operated by the pressure obtained from an elevated tank which supplies water to the producer.

SURGE TANK

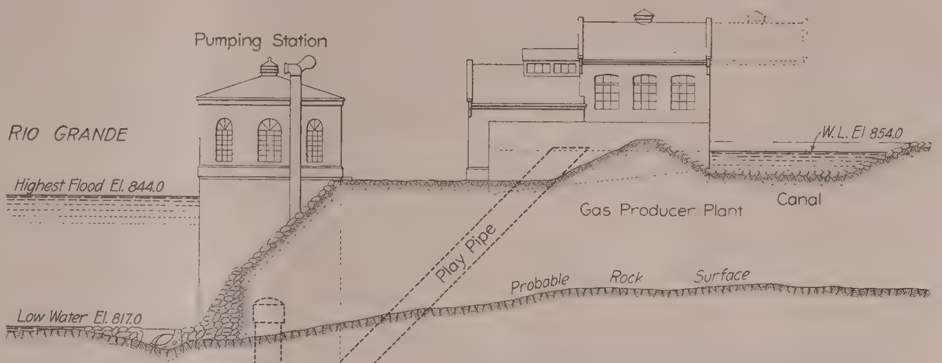
The play pipe discharges into the surge tank shown in the drawing. This surge tank is 36 ft. long and 12 ft. wide and is constructed entirely of reinforced concrete. The discharge pipe extends 9 in. above the normal water level in the canal. The guaranteed lift of the pump is fixed at 37 ft. This is not sufficient to irrigate a tract some 500 acres in extent in the immediate vicinity of the pumping station. To irrigate this land it is intended to take advantage of the wave action in the surge tank and raise thereby a small quantity of water 4 or 5 ft. above the elevation of the water in the supply canal. The arrangement to be used for this purpose is shown. The surge tank is also designed to act as a grit chamber, the grit to be washed into the river through an 18-in. cast-iron pipe.



SECTION THROUGH PUMPING STATION

OPERATION OF PUMP

The operation of the pump is similar to the four-stroke Otto cycle with the exception that in the Humphrey gas pump there is complete expansion, whereas in the Otto cycle the exhaust losses are considerable, the exhaust taking place under a 45-lb. back pressure. To start the pump, the proper mixture of air and gas is forced into a cylinder by a small air compressor of the two-cylinder type, one cylinder pumping air and the other pumping gas. A compressor of this type is essential for safety in order that there may be no explosive mixture in the air compressor. The compressor is driven by a gas engine operated on gasoline.



THE DIRECT-EXPLOSION PUMPING PLANT WHICH WILL RAISE IRRIGATING WATER 37 FEET

Two separate systems of ignition are furnished, one consisting of special spark plugs operated from storage batteries and the other from an electric generator.

After the proper mixture of air and gas is forced into the cylinder by the compressor, the charge is fired by an electric spark, all the valves being shut at the instant when the explosion occurs. The charge of gas and air is exploded directly over the surface of the water, no piston or moving parts being used. The increase in pressure resulting from the explosion, all valves being closed, drives the water in the pump-head downwards and sets the whole column of water in the play pipe in motion. This column of water attains kinetic energy during the period when work is being done upon it by the expanding gases. By the time the gases resulting from the explosion have expanded to atmospheric pressure the water in the play pipe is moving at a very high velocity. As the motion of this column of water cannot be suddenly arrested the pressure in the explosion chamber falls below atmospheric pressure. When this takes place both the scavenging and water valves open. A certain amount of water enters through the suction valves, most of which follows the moving column in the play pipe and the rest rises in the explosion chamber. To assist the scavenging action a certain amount of air is admitted to the explosion chamber to mix with the spent gases. Most of the kinetic energy in the moving column is expended in forcing water into the surge tank.

As soon as the column of water in the play pipe comes to rest, it starts to move back towards the pump and gains in velocity until the water reaches the level of the exhaust valves which are shut by impact. A certain quantity of the burned products mixed with the scavenging air is now imprisoned in the cushioned space and the kinetic energy of the moving column is expended in compressing this gas cushion to a very much greater pressure than due to the static pumping head. As a result of the energy stored up in the entrapped compressed gases, the column of water is again forced outward. The pressure in the gas head is again reduced to atmospheric pressure and below, at which a fresh charge of gas and air is drawn into the explosion chamber. Again the column of water returns under the pressure in the play pipe, compresses the charge of gas and air which is then ignited to start a fresh cycle of operation.

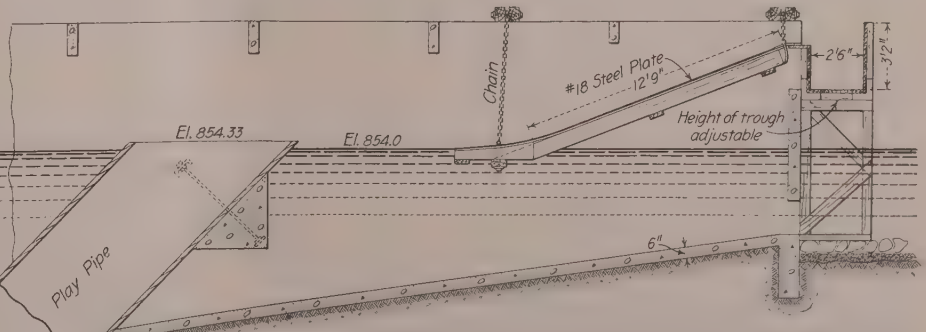
The period of cycle of the pump is determined primarily by the length of the reciprocating column of water in the play pipe. As a general rule, assuming the column to be of uniform section, the period of vibration is almost proportional to the square root of the length of the water column. The Del Rio pump will average about twelve complete cycles per minute.

THERMAL EFFICIENCY

The thermal efficiency of the pump, as mentioned, is guaranteed to be not less than 20 per cent. This appears, according to Mr. Potter, to be very conservative in view of the fact that the official tests made on the five Humphrey pumps at Chingford, near London, show that the large pumps possess a thermal efficiency ranging from 22.19 to 24.07 per cent. The small unit at Chingford showed up still better as it had an average thermal efficiency of 26.36 per cent. Table 3 is a summary of the results of the thirty official tests made on the five Chingford pumps.

GAS PRODUCER PLANT

The gas producer plant will be located adjacent to the surge tank, as shown upon the general plan. The producer system to be used is that of the Standard Gas Power Company, of New York City. It comprises a vertical down-draft generator with a



ADVANTAGE WILL BE TAKEN OF THE SURGE TO RAISE PORTION OF WATER, BY MEANS OF INCLINE, TO HIGH-LEVEL TROUGH

TABLE 3—SUMMARY OF RESULTS OF ENGLISH DIRECT-EXPLOSION PUMP TESTS

Pump No.	1	2	3	4	5
Number of tests	6	6	6	6	6
Average duration of tests, min.	9.27	8.95	8.37	9.67	10.00
Lift in feet	30.01	30.24	30.06	32.60	30.24
Water pumped, gal.-min.	40,088	39,327	39,656	39,196	21,739
Water horsepower developed	303.9	300.4	301.1	322.7	166.0
Gas used per min. at 60 deg. F. and 30-in. mercury cu. ft.	395.4	393.3	391.5	400.1	191.6
Calorific (lower) value of gas, B.t.u. cu. ft.	145.7	146.4	146.2	142.2	138.1
Average thermal efficiency, per cent	22.39	22.19	22.33	24.07	26.63
Anthracite used per water-hp.-hr., lb.	.946	.957	.949	.881	.796

water pan on top and a vapor ring around the combustion belt; air is admitted to the vapor ring and the mixture of air and steam enters the fuel chamber above the green charge. The gas is let in, in succession, through a spray-cooler, wet-scrubber, exhauster, dry purifier and a delivery pipe. The outside dimensions of the generator are 10 ft. 2 in. x 11 ft. 6 in.

The producer, when using moderately dry mesquite wood, will have a capacity per hour of 5,000,000 B.t.u. generated in the form of gas. The minimum heat value of the gas per cubic foot is guaranteed at 100 B.t.u., the quality of the gas not to vary more than 10 per cent from the average.

ECONOMY OF PUMPING PROJECT COMPARED WITH GRAVITY SUPPLY

The estimated cost of constructing the pumping station, including head works, forebay, diversion dam and surge tank, is $60,000, of which amount the machinery, including the producer, represents approximately 50 per cent. The annual cost of maintaining and operating this pumping station, including fixed charges and depreciation, is $13,606. This amount is based upon irrigating the entire tract of 6700 acres to a depth of 3 ft., corresponding to a fuel cost of 30 cents per acre irrigated and a gross charge of $2.06 for all fixed charges and maintenance, including fuel.

The alternative gravity supply project, on the other hand, would have involved an immediate expenditure of $300,000 and a yearly expenditure for fixed charges, maintenance and operation, of $40,000. As the gravity canal would irrigate some 12,000 acres, this would place the gross charge per acre at $3.33.

Defective Valves Cause Slippage in Pumping Engines

Vagaries of Wear Show Inadvisability of Basing Figure for Slip on Time Pump Has Been in Service

By ALAN A. WOOD
Providence, R. I.

FORMERLY it was believed that practically all of the slip in pumping engines takes place in the form of leakage past the plungers. With the advent of pumps employing comparatively high piston speeds, however, this became no longer true. The illustrations show two pump valves of standard rubber construction, giving two views of each. Figs. 1 and 2 were taken from a valve which had been in service in a triple-expansion pumping-engine at one of the plants of a large New England waterworks. Fig. 1 shows to good advantage the amount of wear after the valve had been in service about 17 months. The depressions worn into the face of the valve attain a depth of slightly more than 3/8 in. at some points and the segments thereby outlined resemble somewhat closely the frog of a horse's hoof. After a certain depth has been reached there seems to be a tendency for the raised portion to tear away from the layer beneath.

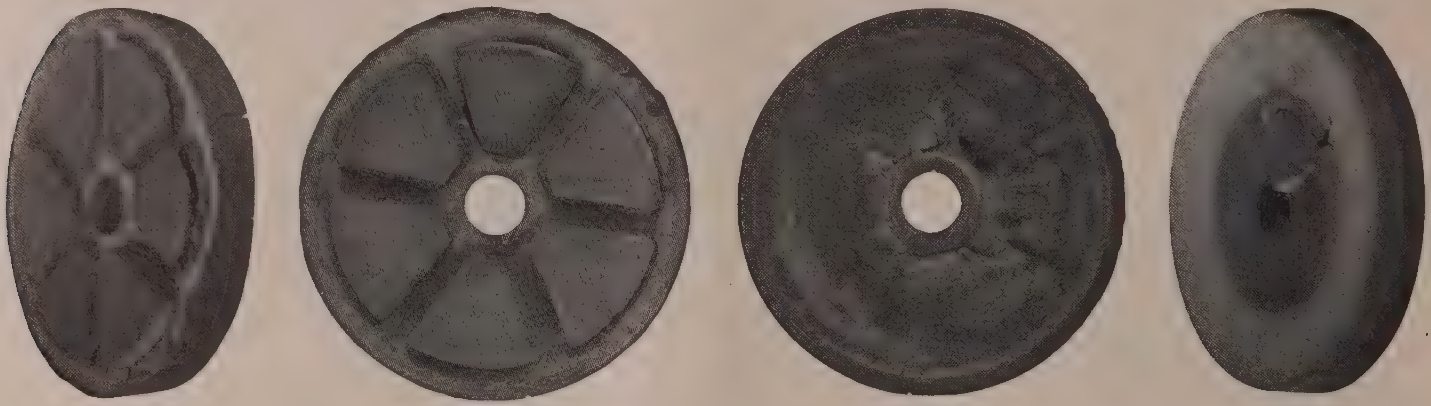


Fig. 1 Fig. 2 Fig. 3 Fig. 4

WORN VALVES, TAKEN FROM A TRIPLE-EXPANSION PUMPING ENGINE, CONTRIBUTED TO SLIPPAGE

Figs. 3 and 4 show a valve worn in an entirely different manner. The material in this valve was quite evidently not so tough as that in the previous one, although both came from the same maker. Instead of wearing radial valleys or depressions into the valve, a turning movement was introduced, thereby resulting in abrasure and tearing of the valve, this being especially noticeable at the joining surfaces where the two layers had been vulcanized together. This action continued until a thin spot developed, at which point the pressure burst through the remaining layer. This valve must have contributed materially to the slippage in the pump of which it formed a part. It had been in service for about 14 months.

It has been found rather questionable practice to depend upon the sense of hearing to determine the condition of the valves. If a number of slightly defective valves are in use the noise is frequently indistinguishable, perhaps because the sounds occur so frequently as to overlap and be absorbed in the general noise of the engine room. On the other hand, if a few of the valves are seriously defective they usually make their presence known unmistakably.

Another conclusion to be drawn is that it is idle to assume the slippage at some arbitrary figure, depending on time of service.

Mr. Edison Defends Concrete as Fire-Resisting Material

IN connection with the behavior of reinforced concrete and other materials in the Edison fire, Thomas A. Edison has written the following letter to the editor:

SIR: The Detroit Brick Manufacturers and Dealers Association is distributing throughout the United States a pamphlet entitled "The Edison Fire," the contents consisting of a reprint of an article appearing in a trade journal, "The Clay Worker." The entire purpose of this publication is to discredit, and if possible, retard the use of reinforced concrete in the construction of fireproof buildings.

The results of the fire at my plant on Dec. 9, 1914, are used in an entirely false and misleading manner. Of the seven reinforced-concrete buildings none were destroyed. A small section of the upper floor of one of the buildings fell in, but was supported by the lower floors. The pamphlet referred to presents three views of this, the suggestion being that they were of three different buildings. The brick administration building to which they refer, which remains standing, was protected by an adjacent concrete building and was not subjected to the fire.

Every brick and steel building which was attacked by the fire was completely destroyed, together with all the machinery they contained, while the damage done to the concrete buildings amounted to about 12½ per cent, and of the machinery contained in the concrete buildings 98 per cent was saved and is now in operation. Manufacturing was resumed in some of the old concrete buildings within a few weeks after the date of the fire.

Temperatures were far in excess of those in the ordinary fire, but reinforced concrete showed its superiority over any other fire-resisting material.

I regret that any representative of the brick interests should have seen fit to sponsor this publication, the evident purpose of which is to deceive. The millions of dollars of fire losses in this country annually make it a matter of moment that the superiority of reinforced concrete for fireproof structures should be thoroughly understood, and it is for such purpose that I have written this letter.

Orange, N. J. THOS. A. EDISON.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Fire Wrecks Ten Spans of Belle Isle Bridge, Detroit

Hot Coals from Asphalt Repair Cart Drop on Creosoted Wood-Block Flooring or Short-Circuited Wires Start Blaze

Fanned by a stiff southwest wind, a fire which started about 3 p. m. April 28, by the dropping of red-hot coals on the creosoted wood block pavement of the Belle Isle Bridge, Detroit, or possibly by short-circuited electric wires, completely wrecked one-half of the draw span and nine of the 156-ft. spans on the island end of the bridge, which are now at the bottom of the river. The five pony spans near the island are still standing, but the north end of the draw span is gradually settling and will probably fall. A total loss of between $200,000 and $300,000 is estimated.

According to information received from Robert H. McCormick, city engineer of Detroit, there is uncertainty as to the cause of the fire. It was first supposed to have started from coals dropped by a wagon used for heating asphalt tools. Later developments show that it is possible the fire started from electric wires which pass under the bridge. An investigation is now being made.

The old bridge was built in 1889 by the Milwaukee Bridge and Iron Works, and consisted of iron trusses supporting a timber floor as originally constructed, and more recently paved with creosoted wood block which, also owing to the increased inflammability induced by oil dropped by automobiles, seemed to burn like tinder.

One theory is that the fire was started in at least a dozen places on practically all the long spans from the island end to the middle of the draw span by the passing of a steel cart containing live coals used to heat the irons utilized in laying asphalt pavement. The live coals seem to have been dropped without the knowledge of the driver.

In spite of the efforts of the fire companies and two fire boats, the heat affected the main members of the trusses, which soon crumpled up, and within a very short time the spans were dropping into the river. When the red hot iron girders and truss members fell into the water clouds of steam were produced, and the mass of twisted iron and debris completely blocked the channel.

It is now planned to construct a temporary bridge to provide for the heavy traffic between Detroit and Belle Isle. Council has appropriated $100,000 for this construction, and $10,000 for clearing away the debris from the river, and plans are being drafted subject to the approval of the War Department. Council has voted the expenses of a special election to be held to authorize an immediate bond issue. It now appears probable that the $2,000,000 reinforced-concrete arch structure designed a short time ago by Cass Gilbert, architect, and Barclay Parsons & Klapp, consulting engineers, of New York, may be adopted, and the work of construction of a monumental permanent structure actively pushed.

Construction Starts on Huge Sport Arena at Sheepshead Bay, N. Y.

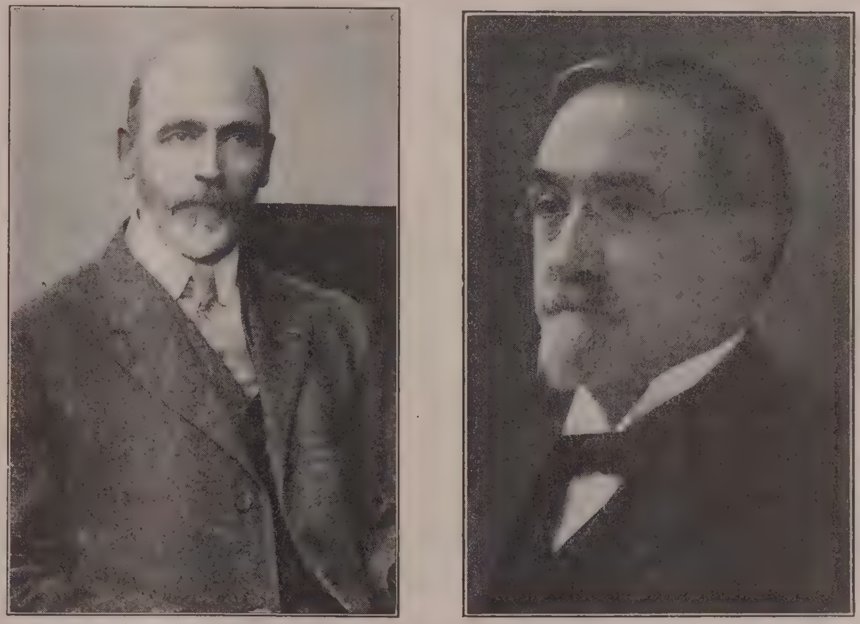
The world's largest sport arena is now being constructed at the site of the old Sheepshead Bay racetrack by the Sheepshead Bay Speedway Corporation. Modern steel and reinforced-concrete grandstands and bleachers are being erected around a 2-mile race track 70 ft. wide. The ultimate capacity of these stands is to be 175,000, which is nearly three times the capacity of the Yale bowl. The grandstands are of the double-deck type, about 90 ft. high, built of steel and reinforced concrete and containing creosoted timber flooring throughout. About 1800 ft. of these stands are to be built this fall in time for the first of the races, now scheduled for the first week in October. Opposite the main stands bleachers about 1600 ft. long will accommodate 30,000 to 40,000 people.

The stands will be entered by concourses crossing above the roadway level. There will be no crossings whatever at grade; automobiles will enter the parking space in the interior of the oval through 30-ft. tunnels which pass under the track. Five of these tunnels are required to provide for the 20,000-automobile capacity of the parking space. It is expected that in addition to automobile races many other sport contests will be held. Unusual facilities are provided for football contests, including a sectional, knockdown wooden grandstand which can be quickly erected in the oval facing the curve of the track. As the space within the oval of the track measures 4000 x 1600 ft. there is ample room for all kinds of sports.

The main track is to be constructed on concrete foundations on the two half-mile straightaway portions, and concrete on structural steel supports on the steep banks of the end curves. In order to prevent unevenness of surface, which at such high speeds as 100 miles per hour would cause the cars to leave the track, a wooden surface is provided, shaped to exact curves at the banked turns. For this flooring 2 x 4-in. creosoted Georgia pine laid on edge is used. The end curves, of about 185 ft. radius, are carefully shaped to provide for varying speeds, from 40 miles per hour at the lower and inner portions to 125 miles per hour at the outer and top portions, with easement curves on the approaches.

When completed, it is expected that the new track will provide record-breaking races within a short distance of New York.

Former Reclamation Service Director and the Veteran Head of the Civil Engineering Department of the University of Illinois Whom He Will Succeed



F. H. NEWELL

IRA O. BAKER

F. H. Newell Succeeds Prof. Ira O. Baker at Illinois

Former Director of Reclamation Service Heads University Civil Engineering Department in Which Prof. Baker Had Served 34 Years

Prof. Ira O. Baker has resigned as head of the civil engineering department of the University of Illinois and has been succeeded in that office by F. H. Newell, formerly consulting engineer of the U. S. Reclamation Service. Professor Baker, who has been head of the department for the past thirty-four years, originally sent in his resignation three years ago, but consented to remain in the office until the right man could be found to occupy it.

He was graduated from the University of Illinois in 1874 and took up faculty work there as assistant professor in physics. In 1879 he was appointed assistant professor of civil engineering, and in 1880 was made professor. In addition to these duties he has been in charge of railway surveys, consulting engineer for the Illinois State Board of Agriculture and consulting engineer on highway bridges at Champlain, Ill. He is well known among engineers for his technical writings and is the author of works on masonry construction, surveying instruments, pavements and kindred subjects, among them being: "A Treatise on Masonry Construction," "Engineer's Surveying Instruments" and "Durability of Brick Pavements."

F. H. Newell

F. H. Newell has been in the service of the U. S. Government in the Geological Survey and in the Reclamation Service for the past twenty-six years. He was graduated from Massachusetts Institute of Technology in 1880 and engaged with private companies and in private practice until 1888 when he entered the service of the U. S. Geological Survey.

In 1907 he was appointed director of the U. S. Reclamation Service and later consulting engineer. He, too, is the author of a number of technical works, among them being: "Agriculture by Irrigation," "Hydrography of the Arid Regions" and "Principles of Irrigation Engineering."

Rockwood Believes New Levee Best Solution of Imperial Valley Problem

"The Imperial Valley is safe from floods of the Colorado River this summer," stated C. R. Rockwood, chief engineer of the Imperial Irrigation District, on the occasion of a recent inspection trip to Volcano Lake levee. Although higher overflow waters are expected this year, due to the deposit of silt in the channel bottom and the choking of the outlet into Hardy's Colorado, there will be no flood, according to Mr. Rockwood, because the levee has been raised from 2 to 7 ft. higher than last year's level.

As far as the future is concerned, he thinks if the river breaks through the Volcano Lake levee, either at Dominiguez slough or at Bowker's gate (the west end) which are the two most dangerous points, there is every likelihood that it will create a new channel to New River, and thence pour into Imperial Lake. It would cost $2,000,000 to turn it back the first year after the break and many millions more in damage to the valley. As a safeguard for the future it is proposed that a new levee be built 4½ mi. to the south and the present levee abandoned. It has been shown that the danger to the levees does not lie in pressure, but in erosion. The present Volcano Lake levee is being constantly undermined by seepage, as is shown by the collection of water in holes on the north side, and the presence of underground springs is thought to render its permanence uncertain.

It is admitted that the new levee will be costly, but Mr. Rockwood believes that it will be less expensive than the continuous repairs on the Volcano Lake levee. The proposed levee would be a continuation of the Saiz levee, and would be built along the high ground just north of the Colorado River, or that section of it known also as the Bee River. It would be 9 miles long, and being on much higher ground would require much less material than the Volcano Lake levee.

Illinois Utility Commission Makes Money for the State

About $670,000 in fees has been collected by the Illinois Public Utilities Commission since it began operations. "Most of this came from the fees on stock or bond issues," said W. A. Shaw, member of the commission, May 3, at the Western Society of Engineers. Of the 3000 docket cases 300 had to do with the issuance of securities. The expenses of the commission have been but $270,000. All money is paid to the State treasurer, funds for expenses being provided only on vote of the legislature. As more funds become available the engineering staff will be enlarged.

Illinois Licensing Bill Progresses

The bill providing for the licensing of engineers in the State of Illinois, which was supported by the Western Society of Engineers, has been reported out favorably by the Illinois House committee.

Chicago Loses Automobile Tax Used for Street Repair

The Supreme Court of Illinois decided April 22 that the wheel tax ordinance of Lincoln, Ill., was unconstitutional insofar as it applied to automobiles, because owners are required to pay the State a tax and to pay a municipal tax which amounted to a double tax.

A sum of more than $500,000 is collected each year in Chicago under a similar ordinance and expended in making repairs. Lawyers in Chicago will assist those of Lincoln in laying plans for a rehearing. They declare that the State may be induced to lower its license fee so that it will not be considered a tax. Then Chicago could go on with its wheel tax. It is the opinion that there will be no refund to automobile owners as the taxes were paid on the assumption that the law was valid and not under duress.

St. Louis Wants Next American Waterworks Convention

If the efforts of the St. Louis members are successful the 1916 convention of the American Waterworks Association will be held in that city. In a letter sent to the members of the society Edward E. Wall, commissioner of the water department, sets forth the advantages of St. Louis for the next annual meeting, laying particular stress upon the opportunity afforded to inspect the city's new mechanical filtration plant, the largest of its type in the world.

New York to Build Three Largest Piers in South Brooklyn

Steps toward building three piers in South Brooklyn larger than any yet built in New York City were taken April 28, when the Sinking Fund Commission authorized the commissioner of docks and ferries, R. A. C. Smith, to prepare plans and specifications for the three. The piers are to run out from Thirteenth, Twenty-ninth and Thirty-fifth Streets, and are to be 1600, 1700 and 1800 ft. long, respectively. The estimated cost for the three piers is $1,260,500 and the estimated annual rentals aggregate $187,000.

Resume Work on Chicago's New Auto Speedway

Work on the 2½-mi. speedway being built by the Chicago Speedway Park Association has been resumed. Contract for lumber to be used was awarded to the Edward Hines Lumber Company. The track will be made of 2 x 4 in. timbers laid on edge. In the building of a fence around the 320-acre tract, and the erection of a grandstand and various buildings, 6,000,000 ft. of material will be used.

Prepare for International Drainage Congress at San Francisco

Arrangements for the International Drainage Congress to be held in San Francisco some time in September are now being made by the National Drainage Congress. The committee in charge of the San Francisco convention is composed of J. L. Craig, Stockton, Cal.; E. T. Perkins, Chicago, and Col. E. J. Watson, Columbia, S. C. Mr. Perkins is in California making arrangements to hold the Congress at the time or near the time of the Engineering Congress. At a meeting April 29, J. L. Craig, fifth vice-president, was appointed fourth vice-president to succeed the late Edwin Wisner, of New Orleans. G. H. Lehman, formerly secretary of the Pittsburgh Flood Commission, was elected fifth vice-president, and J. L. Craig was appointed chairman of the board of local control in charge of the Congress with offices in San Francisco.

Another Waterway Bill Introduced in Illinois Legislature

A so-called mate to the Dunne waterway bill has been introduced in the Illinois Legislature. It provides in substance that such rivers as the Fox, which drains the Shurtleff lakes district north and west of Chicago, may become full fledged arteries of the channel proposed in the Dunne bill. It also provides that the development of the Fox and similar streams shall proceed simultaneously with the deepening of the Illinois River and the Illinois and Michigan Canal. The bill known as the "Shurtleff" bill covers the Sangamon, the Rock, the Kaskaskia and the Wabash Rivers. It also permits the organization of "river improvement districts," composed of two or more counties, which shall have power to take over all territory within a 10-mile radius.

Sixty-Ton Load Smashes Wood Decking Over Subway

Truck Carrying Armature Breaks Through Planking Placed Prior to Excavation for Seventh Avenue Line in New York

At 7:15 a. m. May 6, a 50-ton armature, loaded on a 10-ton underframe truck with wide cast-steel wheels, attempted to cross Seventh Avenue at Forty-second Street, New York City, and broke through the newly laid wooden decking over the subway which is under construction at this point. At 9:30 three automobile trucks hauled the load down Broadway.

This part of Seventh Avenue has just been decked, and no excavation had yet been made below the timbers supporting the plank surface. For this reason, and because the unwieldly load was too high to pass under the overhead pipe lines, the route in front of the Times Building was selected in taking the armature to West Thirty-ninth Street.

In arranging for the passage of the heavy load lines were painted on the street surface planking to guide the wheels of the truck over the stringers. The crew guiding the truck, however, failed to follow the marked route, because it gave them only a few feet clearance from the gas main carried over Seventh Avenue on the north side of Forty-second Street. They steered so that the rear wheels of the truck, carrying most of the load, came between stringers just as the front wheels reached the solid car tracks, when the decking gave way.

Six hydraulic jacks, one under each end of the rear axle, and one under each corner of the timber frame carrying the armature, raised the truck till two 6 x 10-in. timbers could be slipped lengthwise under each wheel. In front of these timbers others were laid crossways, corduroy fashion, and tapered down to the car tracks with 1-in. oak plank. When all was ready three auto trucks, helped by two jacks set against the rear axle of the loaded truck, started the load and hauled it off in safety.

The work was hampered by the dense rush-hour traffic at this corner; cars on Forty-second Street were not even stopped. The big truck was handled with speed and skill, however, by gangs from the Interborough's wrecking department and from the forces of the Rapid Transit Subway Construction Company, contractors for the section on Seventh Avenue, under the personal charge of E. De Ryess, superintendent of the section. Robert Ridgway, engineer of subway construction of the Public Service Commission, was present.

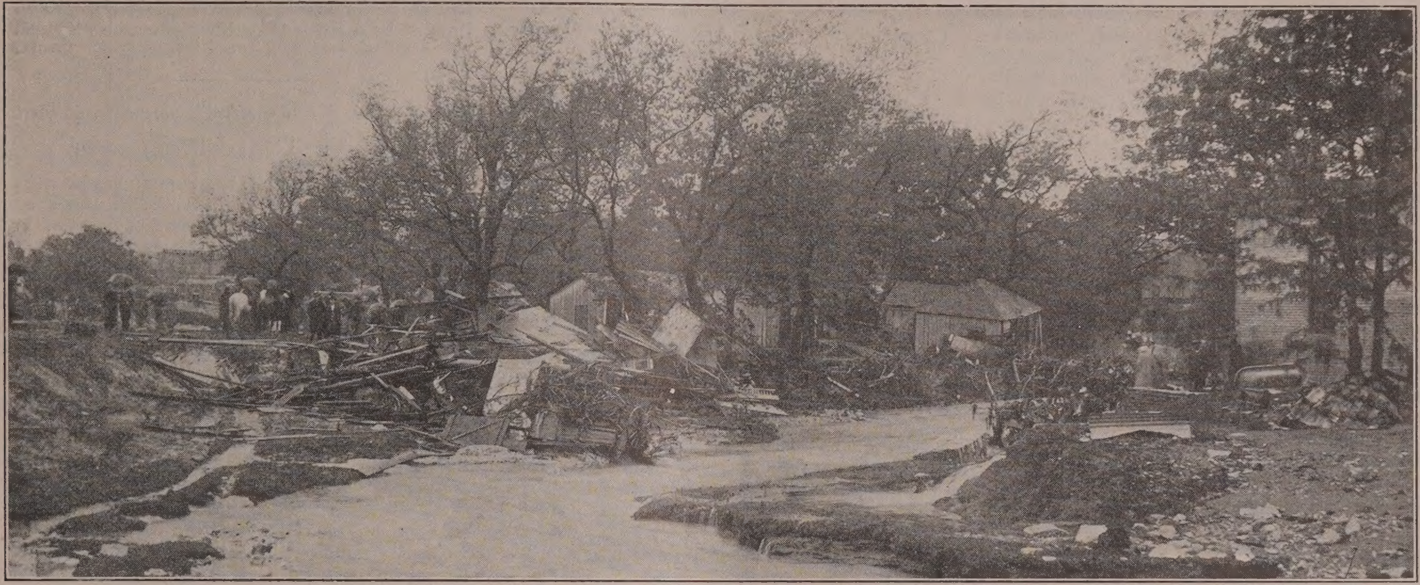
Three similar loads have recently been handled safely past this point.

Studying Seepage at Cedar River Dam Near Seattle

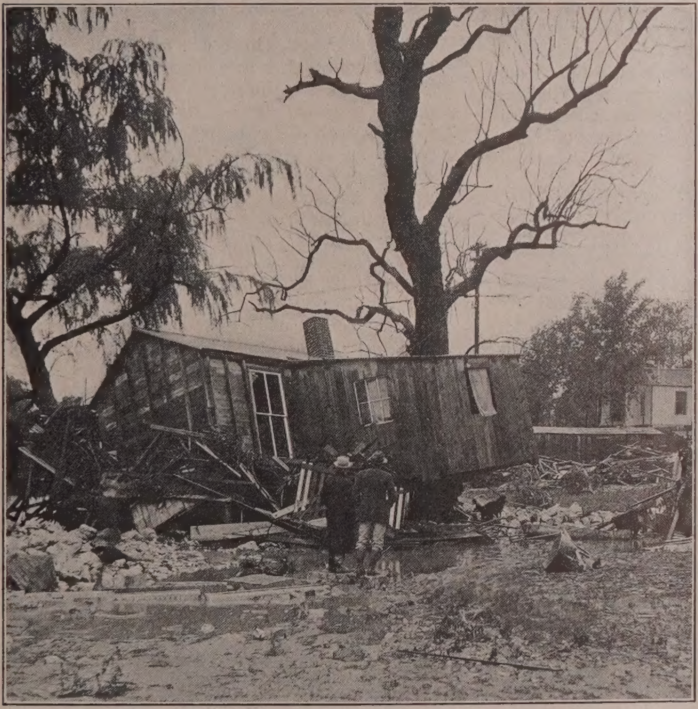
Although the water back of the new Cedar River masonry dam at Seattle fell from the 1537 to the 1535-ft. level, the night of April 23, when the Lake Union steam auxiliary plant was closed down temporarily for repairs, and the Cedar Falls plant carried the entire light and power load, the situation in the Cedar River reservoir remains practically unchanged. Water will be kept at its present level behind the dam until there is no longer a flow over the timber dam in order that the effect of impounding water may be studied in relation to the seepage problem.

The flow of the canyon spring, where a weir

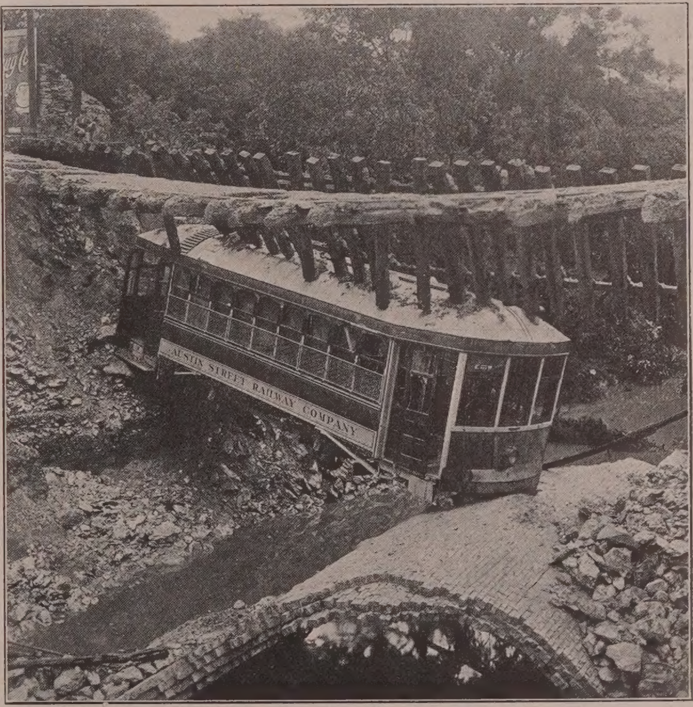
Damage Done by the Recent Floods at Austin, Texas



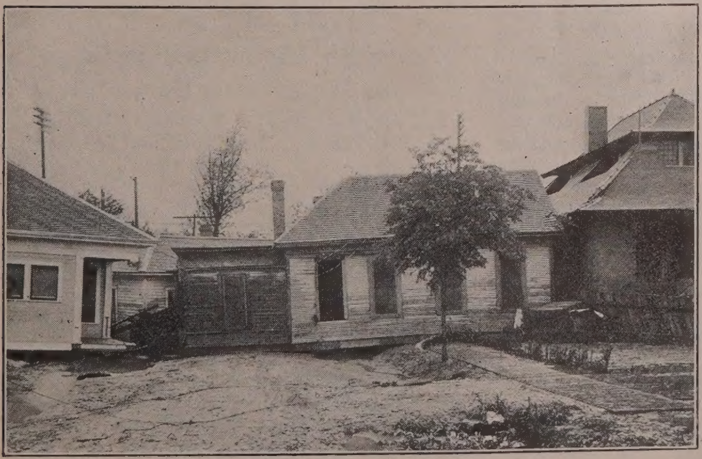
WHEN THE HIGH WATER SUBSIDED THE CREEKS THROUGH AUSTIN WERE CLUTTERED WITH THE WRECKAGE OF BUILDINGS AND BRIDGES



HOUSE FLOATED FROM ITS ORIGINAL LOCATION



EMBANKMENT WASHOUT DROPS CAR ON CULVERT



WATER FROM SWOLLEN STREAMS LIFTED WOOD-FRAME HOUSES FROM THEIR FOUNDATIONS AND CARRIED THEM TO NEW SITES is placed to study the seepage, has remained at approximately 71 sec.-ft. for several days. This is the maximum flow. A. H. Dimock, city engineer, is preparing a report which will be submitted to the council at an early meeting, giving approximate estimates and recommendations regarding the cost of repairing the masonry dam. Estimates of the cost of silting and of constructing a wing wall will be submitted.

Convict Labor on Highways Now Legal in California

The bill permitting the employment of prisoners serving sentences in Folsom and San Quentin penitentiaries on State highway work has been signed by Governor Johnson of California. C. F. Stern, highway commissioner and original advocate of the bill, plans to take personal charge of the convicts. It is planned to gradually work out an honor system. Faithful work will be rewarded by reductions of prison terms. The roads upon which convicts will work will be built in inaccessible and remote districts and in localities where otherwise roads would not be constructed.

First Pile Driven at Portland for Columbia River Bridge

Construction on the interstate highway bridge over the Columbia River at Portland, Ore., was commenced on April 26 when the first pile was driven in the Oregon slough. The contractors are rushing the work in an effort to get the caisson for the first pier from the Oregon shore in place before the June flood comes. If they succeed construction can proceed across the Oregon and Columbia sloughs in spite of the high water, but if they do not the preliminary dredging and piling will have to be done again after a period of three months of high water, during which the contractors can do little or nothing. The Pacific Bridge Company holds the contract for the work.

Power of State to Order Water and Sewer Systems Upheld

The law which gives the Maryland State Department of Health the power to require the installation of water supply and sewerage systems and imposes the duty of raising the funds for such purposes upon municipal officials has been held constitutional by the highest court of that State.

Officers Nominated by American Society for Testing Materials

The nominating committee of the American Society for Testing Materials at a meeting held in New York City, March 6, unanimously agreed to the following nominations: For president, Mansfield Merriman; for vice-president, William H. Bixby; for members of executive committee, James H. Gibboney, William K. Hatt, John A. Mathews and Edward Orton, Jr.

In addition to recommending the proposed amendments to the by-laws noted in the Engineering Record, April 17, the executive committee has decided to recommend an amendment which, if adopted, will result in the use of the inclusive term "Standards" for standard specifications, standard methods, standard tests, and standard definitions, and the requirements that, in general, proposed new standards or proposed amendments of existing standards shall be published in the Year-Book for one year as "Tentative Standards" on which written discussions addressed to the appropriate committee shall be invited.

The following special rates have been obtained for members and their guests at the Hotel Traymore, Atlantic City, for the annual meeting to be held there June 22 to 26: American plan, one person, $5 and $6; two persons, $10 and $12; European plan, one person, $3 and $4; two persons, $6 and $8.

Commission Approves New Grade Crossing Plan at Syracuse

A new plan for the elimination of the grade crossings of the New York Central Railroad in Syracuse, N. Y., prepared by Henry C. Allen, chief engineer of the Syracuse Grade Crossing Commission, has been approved by the commission. The plan is now being considered by the railroad officials. It contemplates occupying the bed of the Erie Canal in the eastern section of the city, and swinging northward to the West Shore tracks between State and Salina Streets. The tracks would pass under the intersecting streets as far west as Leavenworth Street, would come to grade at Sand and Geddes Streets and would from that point west be elevated.

As to the tunnel route under the eastern section of the city proposed by the Mayor, Mr. Allen has stated to the commission that he is not impressed with its practicability from any point of view. The tunnel would be a mile long, would cost at least $4,000,000 and would involve various complications.

U. S. Geological Survey Establishes New England Office

The U. S. Geological Survey investigations of the water resources of the New England States will be carried on hereafter from the district office that has recently been established in Boston. Hitherto this work has been carried on from the New York district office at Albany.

To Introduce Water-Power Leasing at Next Session of Congress

In connection with the water-power leasing bill passed by the House of Representatives last session, but which failed in the Senate, Secretary Lane stated this week that the bill would be introduced immediately upon the convening of Congress, and expressed the hope that it would be speedily passed. As showing the necessity for such legislation to safeguard the public interest, he called attention to the rumor of consolidation of western water-power companies in Colorado, Utah, Idaho, Montana and Washington, which, if fully consummated, will place under single corporate control about 50 per cent of the developed water power of the western States. Such a consolidation, involving widely separated power plants, inter- and intrastate transmission lines, and Federal questions beyond the scope of State utility commissions, emphasizes the necessity of Federal control and regulation in the interests of the people, according to Secretary Lane.

To Ask for New $12,000,000 Bond Issue for California Highways

Resolutions indorsing the proposal to ask the people of California to vote a $12,000,000 bond issue to carry on the work of building State highways were adopted unanimously by a joint meeting of the State Senate and Assembly members of the committee on roads and highways, April 20. The meeting was called at the request of the highway commission, whose representatives were present to show the necessity for more funds.

Highway Commissioner Blaney said that of the $18,000,000 voted in the original bond issue $8,600,000 had been spent; additional contracts let totaled $3,700,000; the amount needed to complete the 1059 miles of trunk line was $11,150,000; to complete the 1163 miles of laterals $6,208,000 was required and contingencies called for $342,000; making a total of $30,000,000 for the completion of the 3249 miles embraced in the system. At the present rate of expenditure the remainder of the $18,000,000 bond issue will be expended within twenty months, he said, and unless more money is forthcoming the organization would have to be disbanded or the system be disposed of at an enormous economic loss.

Dr. J. A. L. Waddell Receives Engineering Degree from Japan

The degree of doctor of engineering has been conferred on Dr. J. A. L. Waddell, of Kansas City, by the Japanese Government in recognition of his services to the engineering profession. This is the highest scholastic honor within the power of that Government to confer. Dr. Waddell was graduated from Rensselaer Polytechnic Institute in 1875 and served for a short time on the engineering forces of the Canadian Pacific Railway, after which he returned to Rensselaer as assistant professor in mathematics. After teaching there for a period of two years, he assumed the chair of civil engineering in the Imperial University of Tokio, Japan, which office he occupied until 1886, when he returned to this country as the representative of the Phoenix Bridge Company, in Kansas City. A short time later he resigned from this position to devote himself entirely to private practice. He is the author of several works, among them being "The Designing of Ordinary Iron Highway Bridges" and "De Pontibus." The degrees of D.Sc., LL.D., and D.E. have been conferred upon him by American universities since 1904.

Pan-American Road Congress to Have Two Classes of Members

Among the measures adopted at a meeting of the executive committee of the Pan-American Road Congress, held at New York City, April 26, was one providing that there be two classes of members of the congress, to be known respectively as Donor and Temporary members.

The first class will be composed of those who pay not less than $50 and the second of those who pay a fee of $2. Both classes will be entitled to participate in the proceedings of the congress and to receive the printed proceedings to be issued thereafter. Donor members will be entitled to the nomination of one temporary member for every $10 subscribed by them, such members to be accorded the privileges and receive the publication, the same as other temporary members. All members in good standing of the American Road Builders' Association and the American Highway Association, as of June 1, 1915, will have all the rights and privileges of temporary members. Those present at the meeting were Gov. Charles W. Gates, of Vermont, chairman; W. W. Crosby, James H. MacDonald, J. E. Pennybacker, E. L. Powers and other members of the committee.

American Highway Association Issues Year Book

Six States—Illinois, Kentucky, Massachusetts, New Jersey, New York and Wisconsin—now have civil service laws providing for appointment of highway engineers and employees in accordance with the merit system. A description of the system in effect in each of the six States appears in the Good Roads Year Book just issued by the American Highway Association, at Washington. The summary of automobile legislation in all the States is of interest in view of the fact that nearly 1,900,000 automobiles were registered in the United States during 1914 for which more than $12,000,000 in license fees was paid.

A majority of the States are now trying out the plan of working convicts on public roads. In some States the honor system prevails and guards are partially or wholly dispensed with. In other States guards are deemed essential, and between the two systems much controversy rages. The Year Book, with its complete digest of convict labor laws for all the States and its many references, throws much light on the subject. That convict labor will go far toward solving the road problem is demonstrated by the experience of Georgia with its army of nearly 6,000 road convicts, and Virginia with about 15,000. The progress reports from these two States appearing in the chapter devoted to highway process show remarkable gains in mileage of improved roads.

Study Lumber by Mail

"Lumber and Its Uses" is the title of a new correspondence-study course offered by the extension division of the University of Wisconsin. The course, which is known officially as Engineering Course 242, will be presented by means of assigned readings from a text book and other printed material. The topics treated are: Structure; physical properties; standard grades and sizes; prices; cost of construction; specific uses; selection of materials; seasoning and preservation, and structural timbers. Paints and stains are also taken up.

News of Engineering Societies

The Southwestern Waterworks Association will hold its fifth annual meeting in Galveston, June 14-16.

The Association of American Portland Cement Manufacturers will hold its spring meeting at the Hotel Blackstone, Chicago, May 10-13.

The Engineers' Club of Philadelphia heard Henry Hess speak on "Engineers as Municipal Executives," at a meeting held in that city May 1.

The National Fire Protection Association will hold its nineteenth annual meeting in New York City May 11-13. Headquarters will be at Hotel Astor.

The American Society of Civil Engineers, at a meeting held at the Society House, New York City, May 5, discussed a paper on "Temperature Changes in Mass Concrete" by Charles H. Paul and A. B. Mayhew.

The Albany Society of Civil Engineers held a special meeting in the City Hall May 7, to receive the report of the legislative committee of the society relative to any change in the organic law of the State which might seem desirable for the constitutional convention to recommend.

The Detroit Engineering Society held its annual banquet April 17. The attendance was about 500. The following officers were elected for the ensuing year: O. W. Albee, president; W. S. Blauvelt, first vice-president; F. H. Mason, second vice-president; H. H. Esselstyn, past-president; and E. M. Walker, secretary and treasurer.

The Utah Society of Engineers held its annual meeting in Salt Lake City, April 16, at which the following officers were elected: President, S. C. Arentz; first vice-president, R. S. Lewis; second vice-president, W. A. Wilson; secretary, C. J. Ulrich; treasurer, L. H. Krebs; members of the executive committee, S. O. Cannon and O. W. Ott.

The Western Society of Engineers was addressed on May 3 by Walter A. Shaw, member of the Illinois Public Utilities Commission, on "The Development and Importance of an Adequate Engineering Department for a Public Service Commission." Monday night meetings in May are as follows: May 10, "The Apportionment of the Cost of Bridges between Street Railways and Cities," by Prof. C. M. Spofford, Massachusetts Institute of Technology; May 17, "Co-operation Among Engineers," by Prof. F. H. Newell, formerly consulting engineer U. S. Reclamation Service and now head of the civil engineering department, University of Illinois; May 24, "Ten Years of Evolution in Hydroelectric Units," by E. B. Ellicott, electrical engineer, Sanitary District of Chicago, and William B. Jackson, consulting engineer.

Personal Notes

T. H. Landon has been appointed city engineer of Alton, Ill.

J. W. Ward has been appointed city engineer of Logansport, Ind.

Le Roy Greenalch assumed office as city engineer of Albany, May 1.

W. F. Fallis has been appointed State highway engineer of North Carolina.

Charles Fisher of Vinton, Iowa, has been appointed county engineer for Jackson County, Iowa.

E. H. Packard has been appointed city engineer of Bloomington, Ill. He succeeds E. Folsom in this office.

H. N. Beck, city engineer of Muskegon, Mich, has been appointed city manager of Grand Haven, Mich.

W. E. Dunn has been appointed county engineer of Hardin County, Iowa, to succeed S. B. Gardner, who recently resigned.

P. F. McManus, formerly a superintendent on the Elgin, Joliet & Eastern Railway, has been appointed general superintendent.

W. R. Wolfinger has been appointed engineer in charge of road work in Franklin, Fulton, Adams and Cumberland Counties, Pa.

Wilbert R. Rosche has opened an office in the Thatcher Building, Pueblo, Cal., for the purpose of practising as a consulting engineer.

E. E. Schuets, formerly county engineer of Merrion County, Mo., has been appointed assistant State highway commissioner of Missouri.

Arthur Capper, assistant county engineer of Dallas County, Iowa, has resigned and established the Capper Engineering Company at Adel, Iowa.

Henry W. Miller, assistant to the president of the Southern Railway, has been elected vice-president of that company with headquarters at Atlanta, Ga.

Alfred Kaufman resigned from the office of city engineer of Albany, April 28. It is said that he will enter the engineering forces of the State highway department.

John Wilson has resigned from the office of city engineer of Duluth, Minn., and will open an office in that city to engage in a private practice as civil and sanitary engineer.

E. V. Frothingham, commissioner of public works of the Borough of Manhattan, New York City, has tendered his resignation to be effective June 1. He was appointed to office Feb., 1910.

E. J. Pearson, whose election as first vice-president of the Texas & Pacific Railway was noted in these columns April 10, has been elected president of the Trans-Mississippi Terminal Company with offices in New Orleans.

Colby & Christie, inspection engineers of Philadelphia, have moved their New York office from 1 Madison Avenue to 165 Broadway. Charles S. Bilyeu, the New York representative of the company, is in charge of this office.

Frank A. Wightman has resigned as a member of the Missouri Public Service Commission to accept an appointment as superintendent of safety of the St. Louis & San Francisco Railroad with headquarters at Springfield, Mo.

R. H. Thomson is to bring the work in Strathcona Park on Vancouver Island to a close this summer pending the end of the European war. After July 1, it is stated, he will open office as consulting engineer in Seattle.

I. R. Ellison, superintendent of the municipal electric light and water system of Eaton Rapids, Mich., has been appointed by the city commission to have charge of the engineering work in connection with the pavements to be constructed in that municipality during the coming season.

F. O. Eichelberger has been appointed city engineer of Dayton, Ohio, succeeding G. C. Cummin, who, as noted in these columns May 1, resigned to become city manager of Jackson, Mich. Mr. Eichelberger was engineer in charge of sewers in the office of which he is now in charge.

William Gerig, vice-president and general manager of the Pacific and Eastern Railway, a subsidiary of the Spokane, Portland and Seattle Company of the Hill system, resigned recently. He will go to St. Paul to take charge of engineering projects in connection with the St. Paul Union station.

P. A. McCarthy & Sons, consulting, designing and supervising engineers of Lufkin, Texas, have opened a testing laboratory as an adjunct to their practice. It is equipped for chemical and physical tests of clays, limes, cement, sand, gravel, stone, concrete, brick, asphalts and other structural materials.

E. A. Hadley, assistant engineer in the service of the Missouri Pacific and St. Louis, Iron Mountain & Southern Railways, has been appointed chief engineer. Mr. Hadley entered the service of the Missouri Pacific in 1910. Previous to that he was on the engineering forces of the Boston & Maine.

F. H. Newell, until recently consulting engineer of the U. S. Reclamation Service, recently delivered a series of three lectures, dealing with the reconnaissance and selection of engineering projects, organization of the work and methods and results, before the College of Engineering of the University of Illinois.

J. A. Farrel, recently elected city commissioner of Duluth, Minn., has been appointed commissioner of public improvements, succeeding R. Murchison. Mr. Farrel has been engaged with the engineering department of Duluth for the past twenty years, having served in the succeeding grades of rodman, instrument man and assistant engineer.

Lyonel Ayres has been appointed city engineer of Duluth, succeeding John Wilson, whose resignation is noted elsewhere in these columns. Mr. Ayres has been engaged in engineering work in Duluth for the past twenty-five years and has been in the public service previously as assistant engineer on the city's forces and as county engineer of St. Louis County.

J. E. Stephens, formerly chief engineer of the Missouri Pacific and St. Louis, Iron Mountain and Southern Railways, has been appointed assistant to the president. Mr. Stephens was graduated from Stevens Institute of Technology in 1878 and entered the railway service in 1880 with the Oregon Railway & Navigation Company. Since then he has engaged exclusively in railroad work in various parts of the United States and Canada, and also in Mexico and South Africa.

Guy Hart, a drainage engineer of the U. S. Department of Agriculture, has been detailed for drainage inspection, survey and organization work in the State of Oregon by the department and will make his headquarters at the Oregon Agriculture College experiment station at Corvallis. Mr. Hart will spend his entire time in the Willamette valley investigating the drainage situation, carrying on experiments in drainage problems and assisting in the organization of drainage district.

Col. S. W. Roessler, Corps of Engineers, U. S. A., was placed on the retired list May 1. He was graduated from West Point in 1881 and attained the grade of colonel in 1909. During his career he had charge of many engineering projects in various parts of the country and is known especially as an expert on matters pertaining to fortifications. His last assignment was in charge of the defensive works at the eastern and southern entrances to New York Harbor and various other works in the same vicinity.

Charles H. Pierce, district engineer of the U. S. Geological Survey, has been designated to take charge of the local work of the Survey in the New England States, with offices in Boston. Mr. Pierce was graduated from the University of Vermont in 1904 and became instrument man on the engineering forces of Newton, Mass. In the fall of that year he entered the railway service and continued in that branch of engineering activity until July, 1906, when he became instructor in mathematics at the University of Illinois. In Sept., 1906, he was appointed assistant professor in civil engineering at the University of Vermont, which office he held until Sept., 1910, when he was appointed assistant engineer in the water resources branch of the U. S. Geological Survey, which is stationed at Honolulu, H. I.

Obituary Notes

George A. Perkins, chairman of the Massachusetts Highway Commission from 1893 to 1896, died at Boston on April 29. In 1887, as a member of the House of Representatives, he introduced the first bill for the improvement of State highways. He also originated the idea and filed the bill establishing the State highway commission.

Gustav Wilke, one of Chicago's earliest skyscraper contractors and a builder of national reputation, died in Chicago April 24. Mr. Wilke was born in Germany in 1853 and came to the United States in 1868. One of his first large contracts was for the construction of the $3,000,000 Texas State House at Austin. He was a member of the contracting firm of Wilke & Hogue.

Alexis H. French, city engineer of Brookline, Mass., since 1894, died in that city May 3. He was born in Weymouth, Mass., in 1851, and was educated at the Massachusetts Institute of Technology. His professional activities were confined exclusively to work in Brookline and he took a prominent part in establishing the local park system there, including co-operative work in connection with the laying out of the Brookline-Boston parkway between the Fenway and Jamaica Pond districts. He was a past president of the Boston Society of Civil Engineers.

Civil Service Examinations

State of Illinois.—An examination for an assistant railroad engineer, salary $160-$200 a month, will be held June 5 at several cities and towns in Illinois, open only to residents of the State. Applicants must by 25 years or over and should have 2 years' experience in railroad construction or operation, with particular knowledge of interlocking plants and signal apparatus. Applications must be on file in the office of the State Civil Service Commission, May 29. Further information may be obtained from the commission, at Springfield, Ill.

Examinations Previously Announced

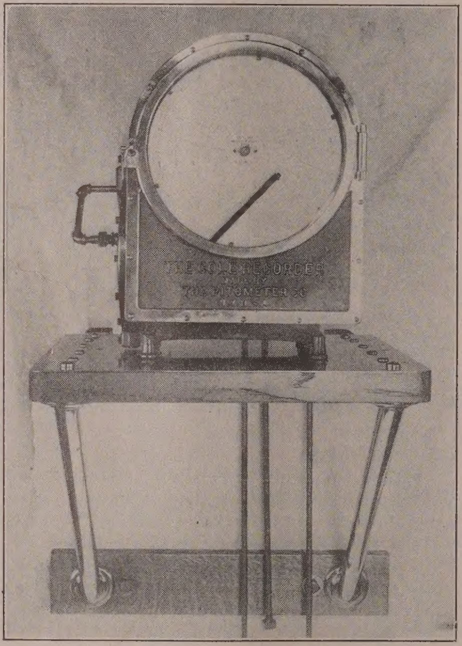
Date.	See Eng. Record
May 10—Architectural draftsman, salary $900-$1200; architectural bridge draftsman, salary $1500; railroad draftsman, salary $1600; Philadelphia	April 24
May 15—Inspector of construction, State of New York; salary $3.50 to $4.50 per day	April 24
June 3—Transitman, Philadelphia; salary $900	April 24
June 4—Second assistant, salary $1000; assistant engineer, salary $4000; Philadelphia	April 24

Cost Review Board Proposed for Yuma Irrigation Project

Since the visit of Secretary of the Interior Lane to the Yuma Irrigation Project, he has completed plans for establishing there a cost review board on the findings of which will depend the charge for the work made by the Government to the water users. The board will include an engineer and a construction expert, and unless its final report is accompanied by a contest from some member or a protest from the water users, the Secretary of the Interior will probably be governed by its findings in apportioning the construction cost.

New Pen Recorder for Pitometer Facilitates Calculations

A new recording device for pitometer readings that marks a step in advance of the Prism photo-recorder, now in use, in that a planimeter may be used in determining the readings, is being put on the market by the Pitometer Company, of New York City. This device, which is known as the Cole recorder, is claimed to be the only pen recorder for pitometer readings that is accurate at low as well as at high velocities.



PEN RECORDS PITOMETER READINGS

The principle of operation is as follows: A multiple diaphragm mounted on the inlet head expands proportionately to the velocity of the water in the pipe. This motion is communicated to a magnet, by means of which it is transmitted to a spiral on which the pen arm rests at stated intervals. The movement of the pen on the chart is limited to the position of the spiral. The outermost points of pen travel on the chart give the record of flow. Though the charts are usually laid out in gallons per 24 hours, any unit which meets the conditions may be used.

Business Notes

The Concrete Steel Company has moved its executive offices to 42 Broadway, New York City.

The American Cement Tile Manufacturing Company has moved its New York offices to 50 Church Street.

The Cleary-White Construction Company has moved its general office in Chicago from 17 North La Salle Street to 105 West Monroe Street.

The Redwood Manufacturers Company, of San Francisco, manufacturers of wood-stave pipe, has moved its offices to the Hobart Building in the same city.

The Sullivan Machinery Company has moved its Denver branch office from 1748 Broadway to the Equitable Building. George W. Blackinton is manager of this office.

Chalmers & Williams, Inc., manufacturers of the Symons Disc Crushers, of 1451 Arnold Street, Chicago Heights, Ill., have moved their New York City offices to the Equitable Building, 120 Broadway.

H. S. Collette, secretary and treasurer of J. G. White & Company, Inc., and the J. G. White Engineering Corporation, has resigned from these companies and expects to reside permanently in California.

Emil E. Lungwitz, New York City representative of the Kelley Filter Press Company and the Galigher Machinery Company of Salt Lake City, has moved his offices from 80 Maiden Lane to the Hudson Terminal Building, 30 Church Street.

The Heltzel Steel Form and Iron Works, manufacturers of the Heltzel system of steel forms, is constructing an addition to its plant that will greatly increase its capacity. The Cleveland office of the company will be discontinued after 1915 and new offices will be opened in Chicago, Pittsburgh and New York. The present plan is to manufacture, on a large scale, the company's new design of sewer, bridge, wall and building forms.

C. L. Remington, general manager of William McLean & Company, merchants, engineers, manufacturers and importers, of Melbourne, Australia, is in this country for the purpose of investigating the methods and equipment used in the construction field in this country. He is, at present, located at 3219 N. Capitol Avenue, Indianapolis, but will shortly join H. P. McColl, the engineer of the company who accompanies him on this mission, at Hotel La Salle, Chicago, after which they will work through the industrial centers of the East.

Trade Publications

The following companies have recently issued trade literature:

J. D. Fate Company, Plymouth, Ohio. Catalog 2, 9 x 6 in., 52 pages, illustrated. Plymouth gasoline industrial locomotives.

Keuffel & Esser Company, 127 Fulton Street, New York. Leaflet, 5½ x 8¾ in., 4 pages, illustrated. Surveyor's duplex slide rule.

Wylie Company, Fisher Building, Chicago. Catalog, 6 x 9 in., 24 pages, illustrated. Embraces concrete handling equipment, including the Wyliechute.

Royal C. Wise, 9 So. Clinton Street, Chicago. Reference bulletin, 6 x 9 in., 4 pages, illustrated. Description and data on bilge, sump and centrifugal pumps.

Wickes Brothers, Saginaw, Mich. Catalog, 6 x 8 in., 24 pages, illustrated. Deals with the Wickes dry land dredge, which is especially adaptable to ditch and reclamation work.

Ohio Locomotive Crane Company, Bucyrus, Ohio. Catalog, 7 ¾ x 10½ in., 56 pages, illustrated, half-tones and drawings. Describes the Ohio locomotive crane in detail and illustrates it in operation on a variety of jobs.

M. W. Powell Company, 204 Dearborn Street, Chicago. Catalog, 6 x 9 in., 32 pages, illustrated. Contains specifications for composition and gravel, Actinolite and flat tile roofing, and illustrates tool used in applying roofing.

Smith Engineering Works, Milwaukee, Wis. Catalog 254, 6 x 9 in., 48 pages, illustrated. Describes rock crushers, jaw breaker, gyratory and intercone types, screens, grizzlies, bucket elevators and portable rock-crushing outfits.

De La Vergne Machine Company, foot of East 138th Street, New York, Bulletin 138, 8½ x 11 in., 16 pages, illustrated. Describes type FH oil engine, built for high duty service using any crude or fuel oil produced in America.